MAIZE IN MEXICO
A PRELIMINARY SURVEY[1]

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Mexico, even more than any other country of the New World, is the land of maize. There it is the actual staff of life, directly, as well as indirectly, for the vast majority of the inhabitants. Today, as in pre-historic times, the state of the maize crop is the commonest subject for conversation throughout the Republic. Maize is so thoroughly identified with Mexico that a survey of the varieties grown there might be useful to historians, geographers, and anthropologists, as well as to agronomists and geneticists. To students of maize in the United States the Mexican varieties have a special significance. Nearly all of the maize now being grown here must trace back, though often by very complex routes, to varieties once grown in Mexico. Some of the problems of commercial maize breeding in the United States and some of our archaeological problems cannot be solved until we have a more complete understanding of the maize of Mexico.

Any attempt to get a general over-all picture of Mexican maize is a difficult problem. Maize in Mexico is extremely variable; it not only varies in the same way that it does in the United States and with greater magnitude; in Mexico there are further patterns of variation. In the corncrib or the field it varies from plant to plant as do our open-pollinated (i. e., non-hybrid) varieties, but the variation is nearly always greater than in an American cornfield or corncrib. In one Mexican village it often varies widely from field to field for the same variety. Unlike American maize, there are, in addition, great differences between varieties and from region to region. There are frequently as many major kinds of maize in one Mexican village as in the entire United States, yet when one goes to a village in another part of Mexico he may find quite another set of varieties. For instance, there are shown in figure 1 the varieties grown by two Mexican families; one (above), in Toluca near Mexico City; the other (below), from west of Autlán in Jalisco. It is unfortunate that photographs of the plants could not have been included in the picture since variation in plant type was even more extreme than that in ear type. A careful comparison of these two pictures will show that several quite distinct varieties are being grown by each family. Yet none of those grown in Toluca are found in Autlán or vice versa. As a matter of fact, progressive farmers and agronomists in either of these regions know little or nothing about the types of maize grown in the other. The ear at the left in fig. 1 (No. 1 below) belongs to an ancient, well-established type of maize widely grown

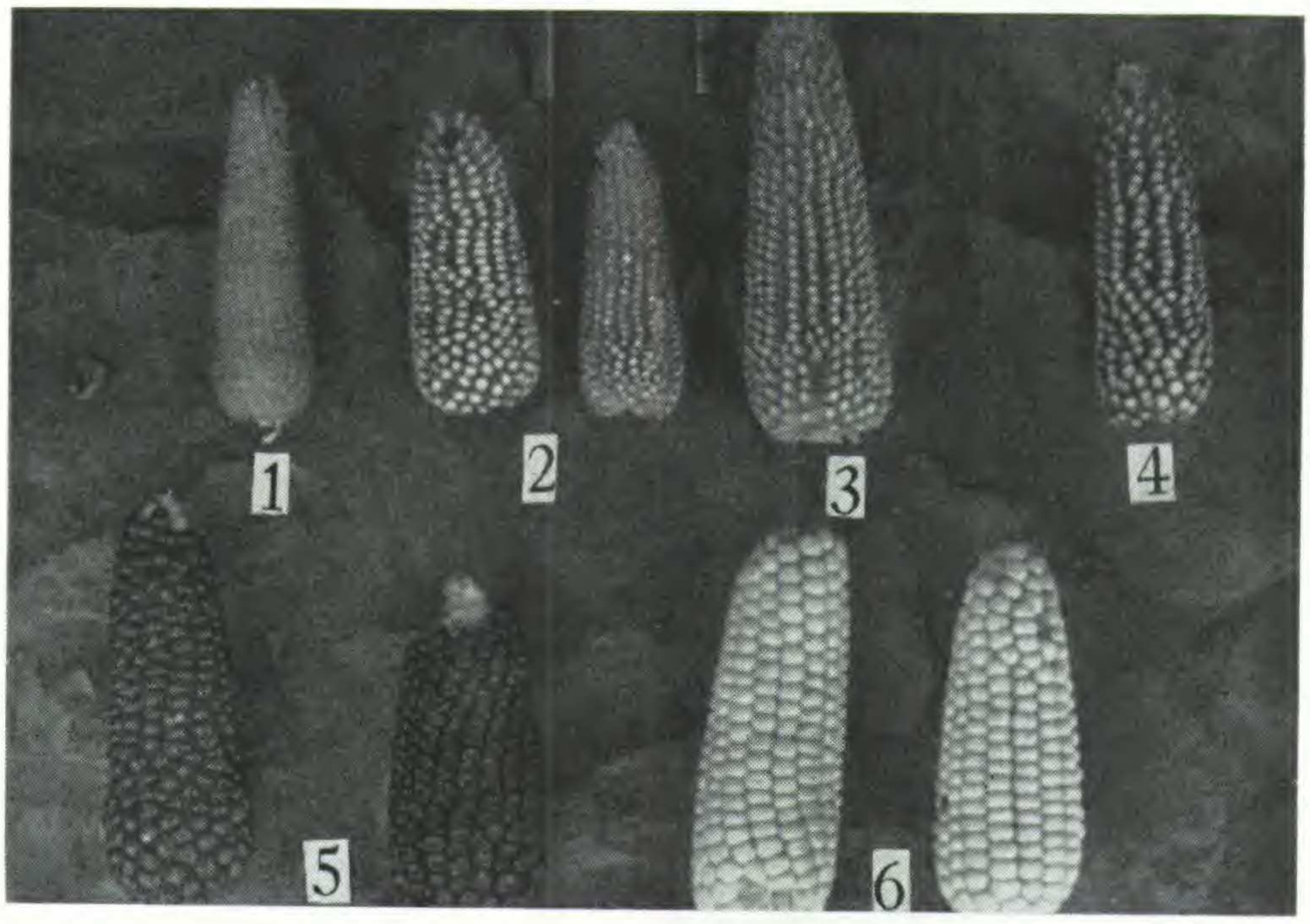
[1] Respectfully dedicated to the maize growers of Mexico who received me with uniform courtesy and furthered these studies in their cornfields and store-houses. Much of the work reported herein was carried on while the author was a Fellow of the Guggenheim Foundation. Acknowledgments are also due to Carl Sauer, Ralph Beals, Isabel Kelly, R. H. Barlow, and E. J. Wellhausen for large and significant collections of Mexican maize turned over to me for study.

in western Mexico (Anderson, 44a). When studying the maize of the Toluca-Mexico City region, ears of this variety were carried about and shown to farmers, plant breeders, and other agriculturists. All were much interested, but none recognized it or knew anything about the general type of maize to which it belonged. Similarly, the small rice popcorns of fig. 1 (above) were carried back from Toluca to Jalisco where they created general amazement when shown to the maize growers of that region, yet the air-line distance between Autlán and Toluca is only 300 miles.

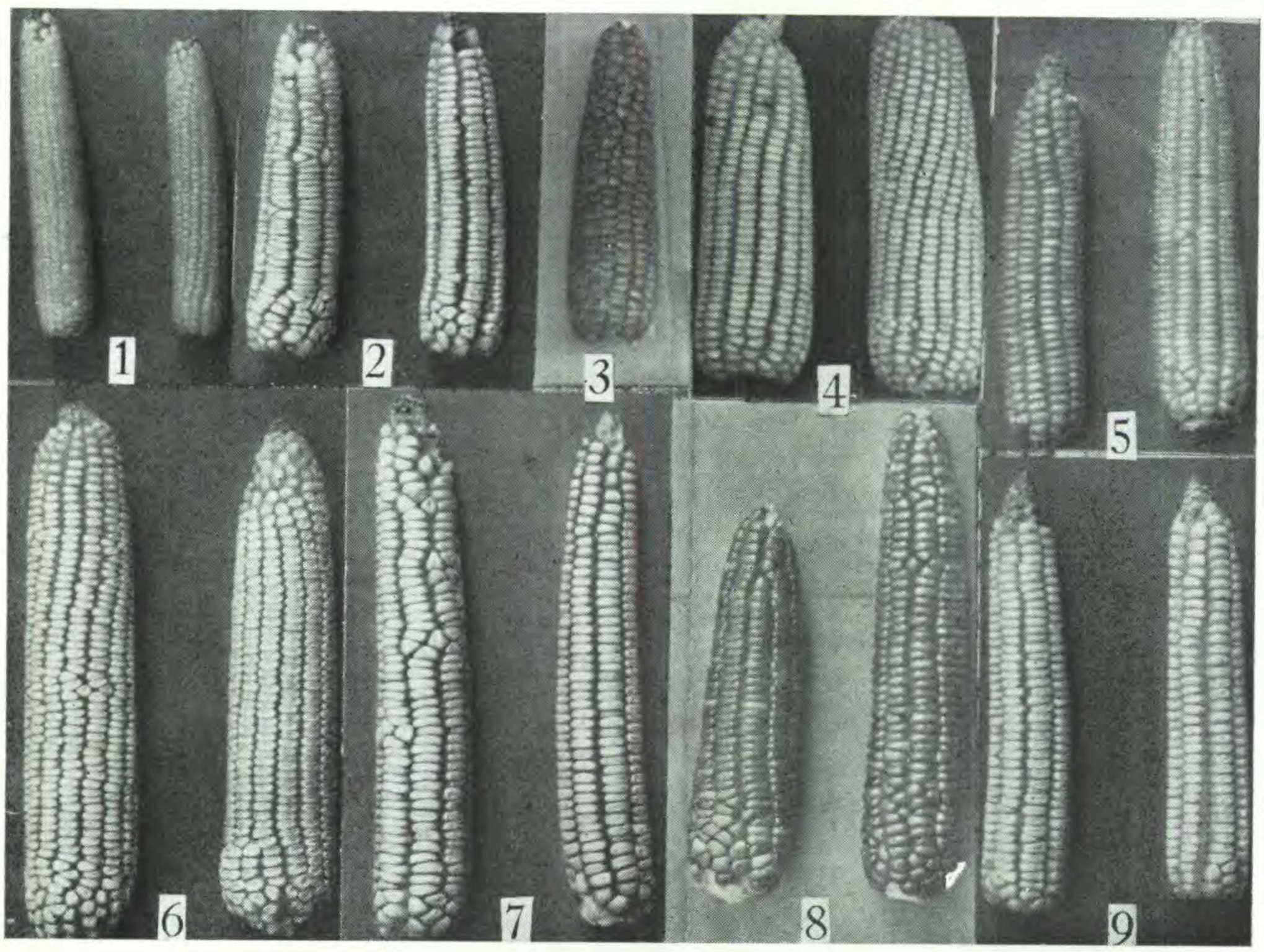
With regional variation piled upon local variation in this fashion, cataloguing the maize of Mexico and discussing the results in general terms is a research problem of no mean dimensions. It is indeed as if one were called upon to discuss the physical anthropology of Europe before any of the technical papers upon that subject had been published (Anderson and Cutler, '42). The present paper is little more than a first approximation. It is based upon six months of residence and travel in Guadalajara and Mexico City and the regions between them, plus five seasons of study in the laboratory and the experimental field of collections made by various collaborators. It scarcely even touches upon such important centers as Oaxaca, Chiapas, and the *barrancas* of western Mexico.

In studying Mexican maize it becomes immediately apparent that the customary pigeon-holes of maize agronomists (popcorn, sweet corn, dent corn, pod corn, flour corn, flint corn) are worse than useless. When these names were set up by E. Lewis Sturtevant in 1884 he dignified them with Latin equivalents, and they have therefore been taken more seriously as outlining real natural entities than he himself ever intended. They will serve as pigeon-holes in most of the United States, though they are artificial and do not divide *Zea Mays* into natural subdivisions. In Mexico they are bad even as pigeon-holes, and furthermore the different ones are bad in different ways. Flint and flour are single gene differences. In regions where both kinds are being grown (Ameca, Jalisco, for example) this single difference may occur in the same field and on the same ear so that shelled kernels from a single ear would have to be classified in two different groups by this system. Pod corn is likewise a single gene difference and, though seldom met with in Mexico, it might be expected to turn up in any kind of maize which was being grown. Sweet corn too is a single gene difference. In the case of Mexican sweet corn this character becomes still less reliable, since Mexican dents carry suppressors which may prevent the sweet character from showing even when it has been inherited.

Dent corns and popcorns however, differ from non-dents and non-pops by a considerable number of genes, and the names delimit more or less natural entities. Yet neither one will serve efficiently in cataloguing Mexican maize. The dent corns vary among themselves in the amount of denting, and they have been so hybridized with non-dented sorts that the classification into dents and non-dents is difficult and subjective in many parts of Mexico. Popcorns are more a group by themselves, or rather two groups. The two most different varieties of corn in



The six varieties of maize grown by one family near Toluca, Mexico: 1, one ear of popcorn; 2, two ears of pop-dent; 3, large yellow pop-dent; 4, pointed yellow corn with flushed pericarp; 5, two ears of "elote" corn; 6, two ears of "cacahuazintle."



Nine varieties common at Purificación, west of Autlán, Jalisco, two ears of each variety: 1, "reventador"; 2, "tabloncillo"; 3, "dulce" (only one ear); 4, "tampenqueño"; 5, "amarillo"; 6, "cuamillero"; 7, "umado" (probably "humiado"); 8, "negro"; 9, "blanco."

FIGURE 1

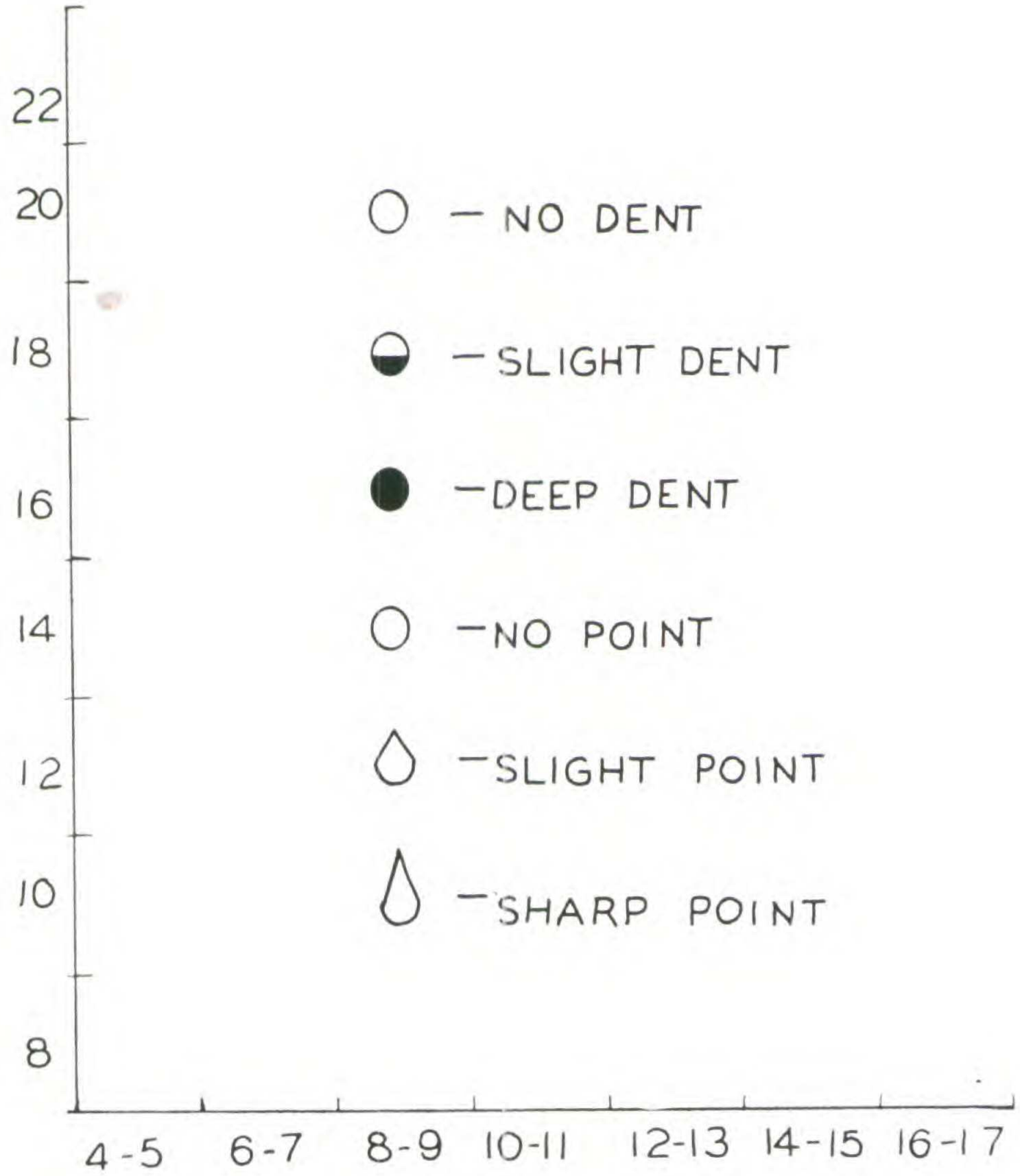


Fig. 2. Grid used throughout this paper and the Appendix for diagramming variation in Mexican maize. Vertical scale, row number; horizontal scale, width of the kernel in mm. The six diagrams illustrate how variation in denting and in pointing of the kernel is represented. Further explanation in the text and in the foreword to the Appendix.

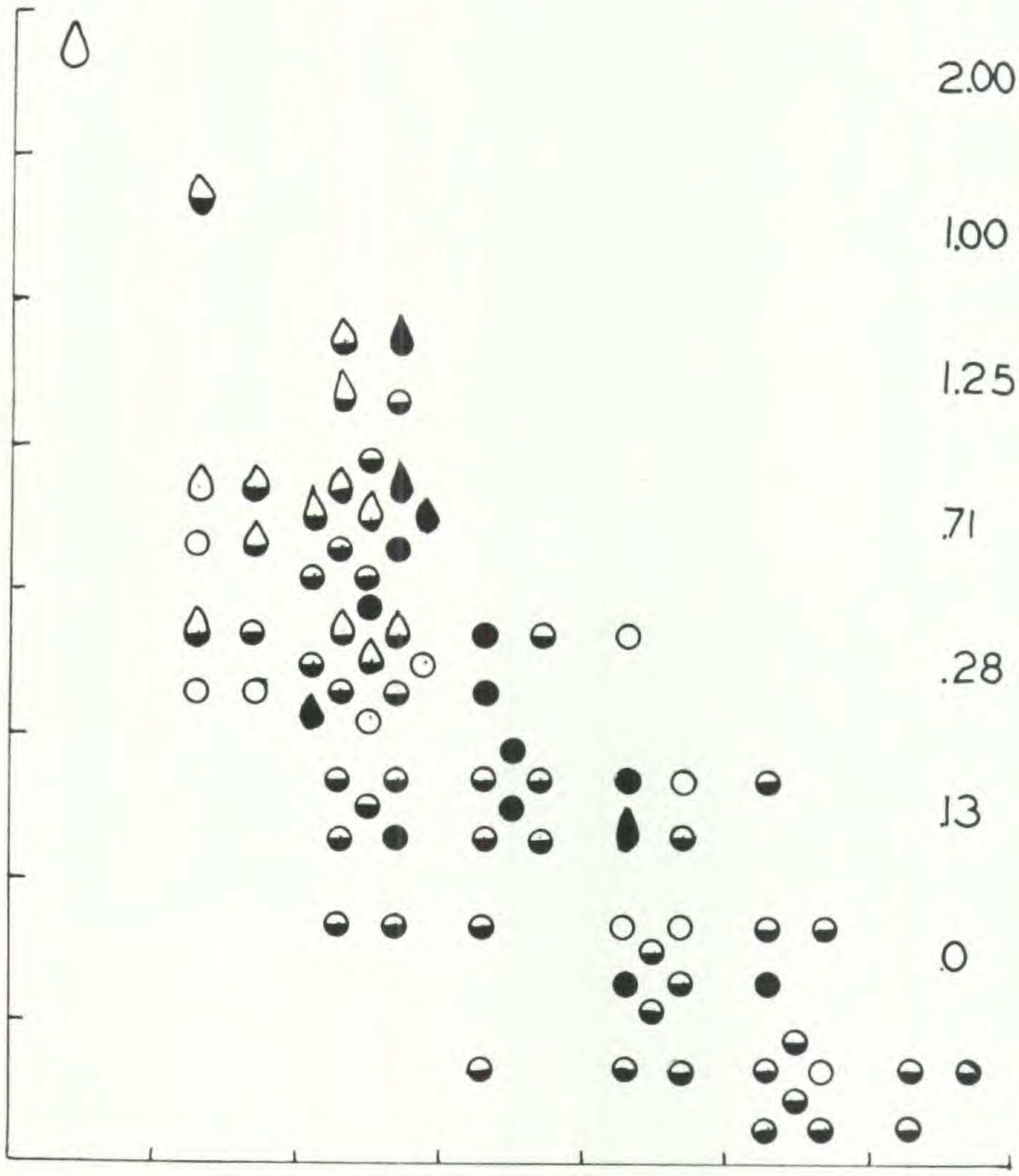


Fig. 3. Averages of all the collections made in Mexico on the same grid illustrated in fig. 2. Each circle represents the average of a single collection. At the right the average degree of pointing has been calculated for each row number (row numbers run from 22 at the top to 8 at the bottom; 2.00, strongly pointed; 1.00, slightly pointed; 0, no point).

all of Mexico are both popcorns. They grow in different regions and on very different-looking plants. When examined cytologically one has a maximum number of chromosome knobs, the other few or none. All they have in common is the ability to pop when heat is applied. Furthermore, one of them (the popcorn of Toluca) is so thoroughly amalgamated with the dent corns of that region that one cannot tell where dent corns leave off and popcorns begin (see below).

For the above reasons the maize of Mexico could not effectively be catalogued in these formal categories. It therefore became necessary to find a more useful classification. A fine preliminary report was published by the Russian Expedition (Kuleshov, '30) and with that as a basis it was possible from the beginning to work towards a natural system of classification for the maize of Mexico. (For a discussion of natural versus artificial classification see Anderson and Cutler, '42).

METHODS

In beginning the work, collections of maize on the ear were received from H. C. Cutler, Ralph Beals, and Isabel Kelly. It was soon found that in a country with an ancient, indigenous civilization like Mexico, archaeologists, geographers, or even historians, were better collaborators than agronomists and botanists. *Maíz reventador* (Anderson, '44) is an example in point. Dr. Isabel Kelly collected numerous examples of this interesting variety from various localities in Jalisco and Zacatecas, though it was not represented in collections made by agronomists, either Mexican or American.

A variable and cross-pollinated crop such as maize cannot be effectively studied as individuals; more significant than any one plant or any one ear is the variation in the entire field or in the entire corncrib. To study the problem effectively it was therefore necessary to work out techniques for recording and analyzing variations in populations. Seed from samples from various parts of Mexico was grown and studied throughout the growing season. By trial and error, methods were worked out for recording the variation between plants, most particularly the differences between varieties from different parts of Mexico. Herbarium specimens of tassels and leaves were made and assembled with photographs of the original ears, diagrams of the internode patterns, samples of the kernels, and information about the chromosome knobs (in the few cases where that had been determined).

From these preliminary studies characters were chosen according to the following criteria:

1. The characters used should be objective and, if possible, capable of being measured or scored in an exact, objective fashion.
2. Their genetic basis should be broad (i.e., they must depend upon a large number of genes), so that their use will tend to bring genetically similar individuals together.
3. They should tend to characterize the varieties of any one area and to distinguish between the varieties of different areas.

The following characters were finally chosen:

Mid-ear width.—The width of the mature ear with its kernels attached, measured to the nearest millimeter with sliding metal calipers.

Shank diameter.—The diameter of the shank which supports the ear, measured immediately below the ear with sliding metal calipers. Unfortunately, in most Mexican maize this has to be estimated from such portions of the shank as adhere to the ear when it is picked.

Kernel width.—The width of a row of kernels, measured on the ear.

Kernel thickness.—Measured at right angles to the above. In practice the thickness of ten consecutive kernels was measured with the calipers and the result was divided by ten.

Tesselation.—The degree to which the kernels are tesselated (i. e., like tiles in a pavement). This is an important difference but needs to be broken down into such components as variation in kernel size and shape, 6- vs. 5- or 4-sided kernels, etc. In this material it was scored in three grades.

Denting of the kernel.—Scored as absent, slightly developed, strongly developed. A more objective way of scoring since worked out in North American material is: 1, kernel with no denting or capping of soft starch; 2, kernel markedly capped with soft starch but not dented; 3, kernel capped and lightly dented; 4, kernel capped and dented but surface of kernel not conspicuously wrinkled; 5, kernel capped, dented, and wrinkled.

Husk striation.—Longitudinal striations across the face of the kernels due to tight husks. Scored in three grades: 0, absent; 1, striations present but not making grooves across several consecutive kernels; 2, deep striations across the face of consecutive kernels.

Base compression.—Ears tapering slightly toward the base due primarily to tight husks. Scored in three grades.

Row number.—The number of rows, counted about a quarter of the way up the ear from the base, since many varieties have irregular rowing and/or increased row numbers immediately above the base, and many varieties drop out rows progressively between the middle of the ear and the apex.

Pointing of the kernel.—Scored in three grades.

Enlarged base.—Base of the ear, perceptibly wider than the rest. Scored in three grades.

Using these characters, variation in populations was studied from one field to another, largely in Jalisco, Michoacán, and the state of Mexico. In making the actual collections, 25 ears were selected at random from the field or corncrib under study. Except in a few instances, the corn in the crib represented the harvest from a single field. Obvious nubbins and ears on tillers were rejected; otherwise the selection was completely at random. In the corn cribs the micrometer was tossed into the crib and the ear nearest its point was selected for measuring. In fields the fourth plant in the row was taken, then the eighth in the next row, the twelfth in the next, and so on. Whenever possible Leica photographs were made of a portion of the collection. Due to the great scarcity of corn in Mexico, the minimum number of ears was retained as samples; it was usually easy to obtain permission to study the corn if the point was stressed that we did not care to buy it, but merely wanted to study it for an hour or so.

As soon as a few cornfields and corncribs had been sampled it was apparent that an efficient method of analyzing and summarizing the data was of first importance. The variation was too extreme and too manifold to carry in the mind or even to interpret from a series of averages and ranges of variation. What was needed was some method of turning the data on each cornfield into a general

over-all picture of that particular field. The graphical method used in Carter and Anderson's study of the maize of the Southwest ('45) had certain advantages, but the indices were somewhat subjective, the computations involved and there was no transparent relation between the spots on the comparison grid and the actual data. After considerable experimentation the method illustrated in fig. 2 was eventually adopted. It uses the two characters (row number and kernel width) which best fulfil all the criteria mentioned above. They are diagrammed at right angles to each other on Cartesian coordinates, the former being plotted on the vertical axis, the latter on the horizontal. The next two most important characters in studying the maize of Mexico are the denting of the kernel and the degree to which it is pointed. Both of these characters are easy to observe but difficult to score exactly in objective grades. Each was merely recorded as "absent", "weakly developed", or "strongly developed". They are, however, so important in characterizing the maize of different regions and of different varieties in Mexico that they were included in the diagram. This was done graphically as shown in fig. 2. The shape of each individual spot on the diagram shows whether that individual had unpointed, slightly pointed, or sharply pointed kernels. The degree of darkening of the spots shows the amount of denting on the kernels.

The method outlined above makes it possible to "see the woods in spite of the trees" and to compare one field of maize in its entirety with another field measured weeks, months, or even years later. In a variable and cross-pollinated organism such as maize, populations are more significant than individuals. Each individual combination of characters is more or less an accident; what is important is the general complexion of the whole population. If the diagrams in the appendix are examined it will be seen that each population is a more or less coherent whole and that the spots are not spattered at random over the diagram; for each sample they tend to cluster about a particular average. In some cases they are strongly aggregated, in others more dispersed, but even where they are widely scattered they are coherent. In other words, the field from which they came had a significant combination of gene frequencies and the diagram of 25 spots, all seen at once with a glance of the eye, is a fairly efficient reflection of that population. It is at least far more significant than isolated averages or frequency distributions of the four characters taken separately. As an example of how much can be analyzed and demonstrated by these diagrams, compare the two fields of *Maíz criollo* studied at Tlaquepaque with the two studied a few miles to the southwest at El Grullo and Autlán. At Tlaquepaque *Maíz chino* and similar varieties (with higher row numbers and more denting and pointing) are growing, and have been grown for at least a generation, in adjacent fields to the *Maíz criollo*. At Autlán and El Grullo these other varieties are not grown. It will be seen that, although all four diagrams present the same general picture, the spots in the Tlaquepaque diagrams show a tendency to drift up towards higher row numbers and narrower kernels and that in one of them is strong indication of mixture with a highly dented, more pointed-kernelled variety of higher row numbers (Appendix Nos. 1 & 2 vs. 15 & 20).

The results of the Mexican collections are summarized in Table I and the Appendix. In Table I the collections are assembled by communities and according to states, the latter arranged roughly from west to east and from north to south. Averages for ten of the characters are presented for each collection, together with the local name of the variety (as well as the name of the grower, or the location of the field in those cases where several collections in one locality make it necessary for precise identification).

Table I deals only with averages of populations. Records of individuals are presented in Appendix I as photographs of representative ears and diagrams of the type described above. It is apparent from even a casual inspection of Table I and the Appendix that the ten characters presented in the table are not distributed at random. On the whole, the characters tend to be associated in complexes, and these complexes show strong geographical trends. High row number, narrow kernels, and pointing of the kernel tend to go together as one complex which is most frequent in the state of Mexico and becomes increasingly less frequent as one goes westward. These facts are shown more precisely in fig. 3. In that figure each spot represents the average of a collection rather than individual ears. It will be seen that, as a whole, the collections run from narrow-kernelled and many-rowed varieties to wide-kernelled and few-rowed varieties. Furthermore, pointing of the kernel shows a very definite tendency to be associated with narrow kernels and many rows. This is demonstrated statistically at the right of fig. 3. Assigning grades of 2.0 for extreme pointing of the kernel, 1.0 for intermediate pointing, and 0.0 for no pointing, the averages have been calculated for the average (median) ears of each row number. It will be seen that the degree of pointing decreases regularly from 2.0 for 22-rowed ears to 0.0 for ears of 8 and 10 rows.

Table I also shows that this complex of high row number, narrow kernels, and pointed kernels follows a fairly definite trend from western Mexico to central Mexico. In the state of Jalisco, the bulk of the ears measured are 8- to 10-rowed, and population averages never go above 14 rows. While pointed kernels are found in certain varieties, they always represent less than half of the sample. In Michoacán, the next state to the east, there were no collections which averaged less than 12 rows and one which averaged as many as 18, and for some of the collections more than 50 per cent had pointed kernels. Still further east in the state of Mexico, there were no collections with average row numbers below 14, and half of the collections had a majority of pointed kernels.

The geographical trend in pointing and high row numbers is demonstrated more precisely in fig. 4, which presents collection averages for all those communities from which five or more collections had been made. The location of these four communities is shown in fig. 5. It will be seen that in the neighborhood of Autlán, in western Jalisco, all five collections had very similar averages in spite of the fact that the Autlán collections were actually made over a much wider area (San Gabriel to Autlán) than those in the other three communities. At S. P.

Collector	Locality	Number collected	Mid-ear width (cm.)	Shank diam. (cm.)	Kernel width (cm.)	Kernel thickness (cm.)	Denting	Husk striation	Base compression	Number of rows	Pointing	Enlarged base
	SONORA											
E. A.	Magdalena	1	4.3	1.9	1.0	.44	±	±	+	12		
E. A.	Corral	2	3.9	1.3	1.4	.43	±	±	±	9		
	SINALOA											
E. A.	Escuinapa	1	4.0	1.9	1.3	.42	0	+	+	10		
	NAYARIT											
E. A.	Acaponeta	4	3.5	1.5	1.1	.40	+	+	+	10		
E. A.	Tetitlán	2	4.5	2.5	1.3	.43	+	+	±	11		
	JALISCO											
E. A.	Autlán	25	4.1	1.5	1.5	.42	±	+	+	8	0	0
E. A.	El Grullo	25	4.2	1.6	1.5	.43	±	+	±	8	0	0
J.M.C.	El Chante	13	4.2	1.4	1.4	.41	±	+	±	10	0	0
I. K.	" "	2	3.8	1.1	1.1	.29	±	+	±	8	0	0
I. K.	" "	2	4.5	2.1	1.4	.40	0	±	±	10	0	0
I. K.	" "	2	4.4	1.3	.8	.38	±	±	±	16	0	0
I. K.	" "	2	3.9	1.2	1.2	.44	±	±	±	8	0	0
I. K.	" "	2	3.9	1.4	1.6	.36	0	±	±	10	0	0
I. K.	" "	2	2.7	.8	.6	.25	0	+	±	15	0	0
I. K.	" "	2	4.2	1.4	1.5	.43	±	±	±	8	0	0
I. K.	" "	2	5.3	1.5	1.0	.36	±	±	±	16	0	±
I. K.	" "	2	5.1	1.5	1.1	.36	+	±	0	14	0	±
J.M.C.	El Limón	10	3.0	1.1	.6	.32	0	+	+	14	0	0
E. A.	Chachahuatlán	25	3.2	1.0	.7	.35	0	+	+	14	0	0
E. A.	"	25	3.7	1.1	1.3	.35	±	+	±	8	0	0
E. A.	San Gabriel	25	3.8	1.4	1.4	.38	±	+	±	8	0	0
E. A.	Tuxcacuesco	25	3.7	1.3	1.3	.34	±	+	±	8	0	0
E. A.	Palmar	8	4.7	1.6	1.0	.35	+	±	±	14	0	0
I. K.	Union de Tula	1	4.8	1.2	1.0	.40	+	±	±	14	0	0
I. K.	Ayutla	2	4.6	1.2	1.0	.36	±	±	±	16	0	0
E. A.	Ameca	25	4.0	1.4	1.3	.40	±	±	±	10	0	0
E. A.	"	12	4.1	1.3	1.3	.46	0	±	±	10	0	0
E. A.	"	25	3.9	1.5	1.4	.44	0	+	+	8	0	0
E. A.	"	25	4.4	1.7	1.5	.42	+	±	±	10	0	0
E. A.	Tlajomulco	25	3.8	1.3	1.5	.42	±	+	0	8	0	0
E. A.	"	25	5.2	1.9	.8	.45	±	±	±	18	0	0
E. A.	Tlaquepaque	25	4.4	2.1	1.6	.48	±	+	0	8	0	0
E. A.	"	25	5.0	2.0	1.3	.47	±	+	0	12	0	0
E. A.	"	25	5.0	1.9	1.4	.50	±	±	0	12	0	0
E. A.	"	10	4.5	1.9	1.6	.49	±	±	±	8	0	0
E. A.	"	15	4.6	1.7	1.2	.40	+	+	0	12	0	0
E. A.	"	25	4.6	1.5	1.1	.41	±	±	±	12	±	0
E. A.	"	25	4.6	1.6	1.4	.41	+	+	0	12	±	0
E. A.	"	25	4.2	1.7	1.6	.47	±	±	±	8	0	0
E. A.	"	25	3.9	1.3	1.3	.40	±	+	±	10	0	0
E. A.	Tonolá	25	4.1	1.3	1.4	.39	±	+	±	8	0	0
E. A.	Tepatitlán	25	4.2	1.2	1.0	.35	+	±	0	14	0	0
E. A.	"	25	4.6	1.3	.9	.41	+	0	0	14	0	0
E. A.	"	25	3.6	1.0	1.2	.40	+	+	0	8	0	0
E. A.	Apango	5	3.9	1.4	1.1	.47	±	0	0	10	0	±
E. A.	Tapalpa	25	3.7	.9	1.0	.35	±	+	±	8	0	0
E. A.	"	25	3.5	.9	1.0	.39	±	0	0	12	0	±
E. A.	"	25	3.9	1.1	1.4	.37	+	+	0	10	0	0
E. A.	"	25	3.7	1.1	.9	.41	±	0	0	12	0	±
E. A.	"	25	3.1	.9	.9	.36	±	±	0	10	0	±

TABLE I

Collector	Locality	Number collected	Mid-ear width (cm.)	Shank diam. (cm.)	Kernel width (cm.)	Kernel thickness (cm.)	Dent ng	Husk striation	Base compression	Number of rows	Pointing	Enlarged base
	MICHOACÁN											
F.V.T.	Coalcomán area	16	3.9	1.0	.9	.32	±	+	0	10	0	0
F.V.T.	”	15	4.1	1.1	1.2	.37	±	+	±	10	0	0
F.V.T.	”	14	3.9	1.1	1.0	.33	±	±	±	14	0	0
E. A.	Apatzingán	25	4.6	1.4	1.5	.33	±	+	±	10	0	0
E. A.	”	25	4.2	1.3	1.3	.35	±	+	±	10	0	0
E. A.	Sahuayo	3	4.3	1.6	1.4	.44	±	±	±	10	0	0
E. A.	Jiquilpan	7	4.6	1.5	1.0	.41	+	0	0	14	0	0
E. A.	”	25	4.5	1.2	.8	.34	±	±	0	18	±	0
E. A.	”	25	4.7	1.4	1.1	.41	±	±	0	12	0	0
E. A.	”	25	3.1	.9	.8	.34	0	+	+	14	0	0
E. A.	”	25	4.8	1.5	1.2	.40	+	+	±	12	±	0
E. A.	”	25	4.5	1.6	1.3	.45	0	+	±	12	0	0
E. A.	Uruapan	25	4.2	1.2	1.1	.40	±	±	0	12	0	0
E. A.	”	25	4.4	1.7	1.4	.48	±	+	±	10	0	0
E. A.	San Lorenzo	25	4.4	1.4	1.1	.45	+	0	0	12	±	0
E. A.	Cherán	25	3.7	1.3	.8	.44	±	0	0	14	±	0
E. A.	”	25	4.4	1.3	1.0	.50	±	0	±	14	0	0
E. A.	”	25	4.8	1.5	.9	.43	±	0	0	16	±	±
E. A.	Patzcuaro	25	3.7	1.1	.9	.38	±	0	0	12	0	0
E. A.	”	25	4.4	1.3	.9	.42	±	±	0	14	0	±
E. A.	Lake Patzcuaro	25	4.2	1.4	.9	.41	±	0	0	14	0	0
E. A.	” ”	25	4.5	1.4	1.1	.45	±	±	±	12	0	0
E.J.W.	Zitácuaro	25	3.6	.9	.8	.31	±	0	0	12	0	±
	STATE OF MEXICO											
E.J.W.	Toluca–											
	km. 60	25	5.0	.8	1.2	.51	0	±	±	12	0	0
E.J.W.	” km. 57	25	3.4	.8	.4	.28	0	0	0	22	+	0
E.J.W.	” km. 17	25	4.6	1.0	.8	.39	±	0	0	16	0	0
E.J.W.	” km. 17	25	3.9	.9	.8	.37	0	0	0	14	0	0
E.J.W.	” km. 57	25	3.9	.8	.7	.37	±	0	0	16	±	0
E.J.W.	Chalco	25	4.9	.9	.9	.42	+	0	0	14	±	0
E.J.W.	Metepec	25	4.7	1.1	.8	.41	+	0	0	16	±	0
E. A.	Tepotzotlán	25	5.1	1.1	.8	.40	±	0	0	16	0	0
E. A.	Huehuetoca	25	4.4	.9	.8	.41	±	0	±	16	0	0
E. A.	Acupula	25	3.9	.7	.7	.37	0	±	±	16	0	0
E. A.	Huehuetoca	22	4.2	.8	.8	.42	±	±	±	14	0	0
	GUANAJUATO											
E. A.	León	25	4.6	1.4	.8	.35	±	0	0	16	0	0
E. A.	”	25	4.2	1.3	.9	.35	±	0	0	16	0	0
	MORÉLOS											
E. A.	Tlaltitzapán	25	5.3	1.1	.8	.32	±	±	0	16	+	0
E. A.	”	25	4.4	.8	1.1	.33	+	±	±	12	0	0
	PUEBLA											
R.H.B.	Otlatlán	25	4.5	.8	.8	.43	±	±	0	16	0	0

TABLE I *(Continued)*

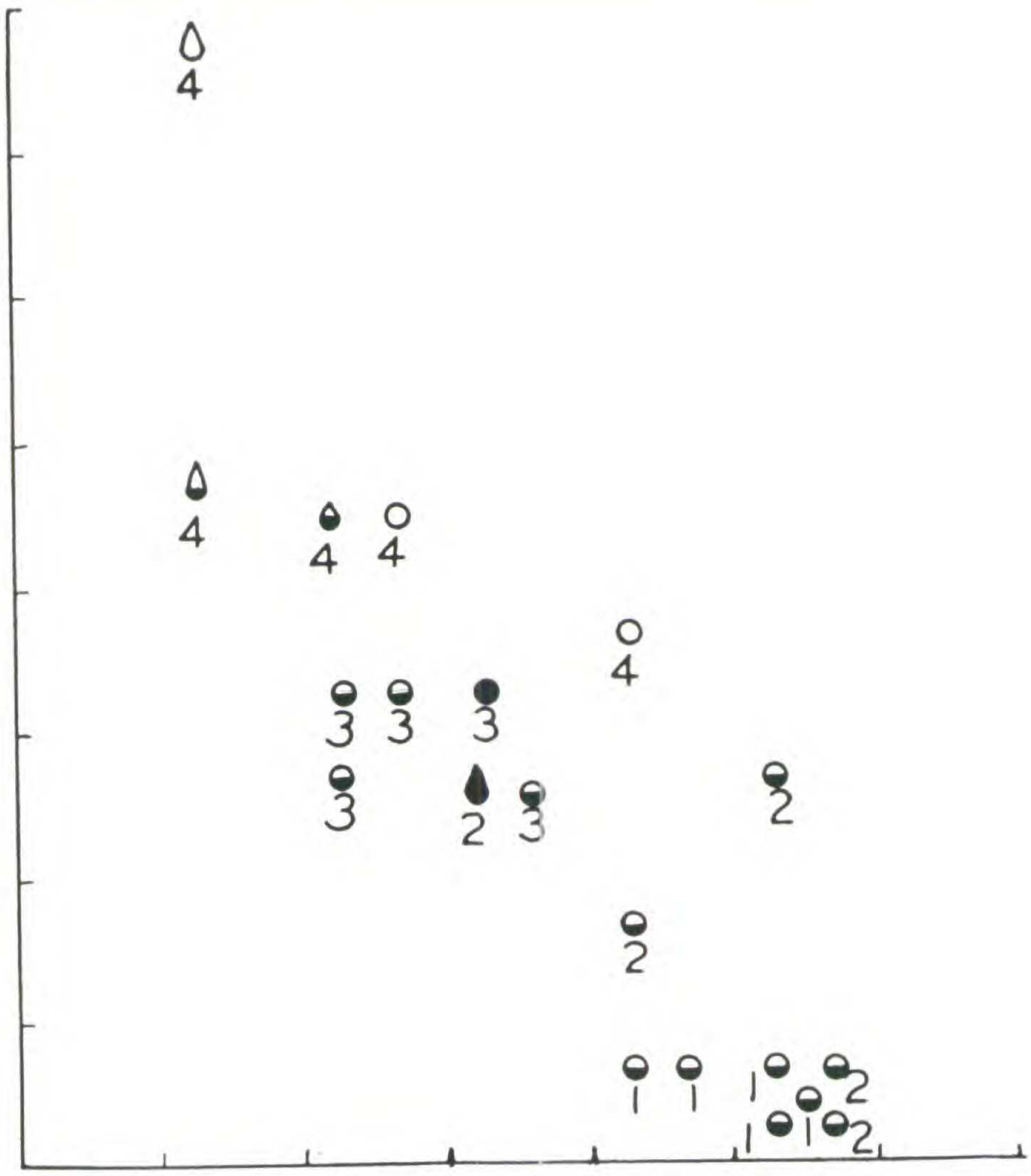


Fig. 4. Averages of 5 varieties of maize grown at each of the following towns: 1, Autlán in western Jalisco; 2, S.P. Tlaquepaque in central Jalisco; 3, Patzcuaro, Michoacán; 4, Toluca, Mexico. Each circle represents a collection of 25 ears averaged for row number, kernel width, denting of the kernel, and pointing of the kernel.

Tlaquepaque, a suburb of Guadalajara, some of the five collections are from adjacent fields and none is more than a mile distant from any of the others. These Tlaquepaque averages are particularly significant because although two of them are quite as extreme as those from Autlán, the other three are not, and one of the collections averages exactly the same as one from Patzcuaro, Michoacán. The Toluca collections present the other extreme. It will be noted that three of the five have a majority of pointed kernels and that all of them average 14 or more rows. Here again it should be pointed out that while these collections were made within a few miles of each other and some of them from adjacent fields, one of the collections is no more extreme on the average than are those from Patzcuaro. Figure 4 therefore demonstrates a fact which is borne out repeatedly in the detailed observations reported in the Appendix: The pointed-kernel, high row-number complex is not a direct effect of the environment. It is possible to grow

unpointed, few-kernelled varieties in central Mexico or many-rowed and pointed-kernelled ones in Jalisco. On the average, however, this is not done, and there is a strong and surprisingly regular gradient in these characters between Mexico City and western Jalisco.

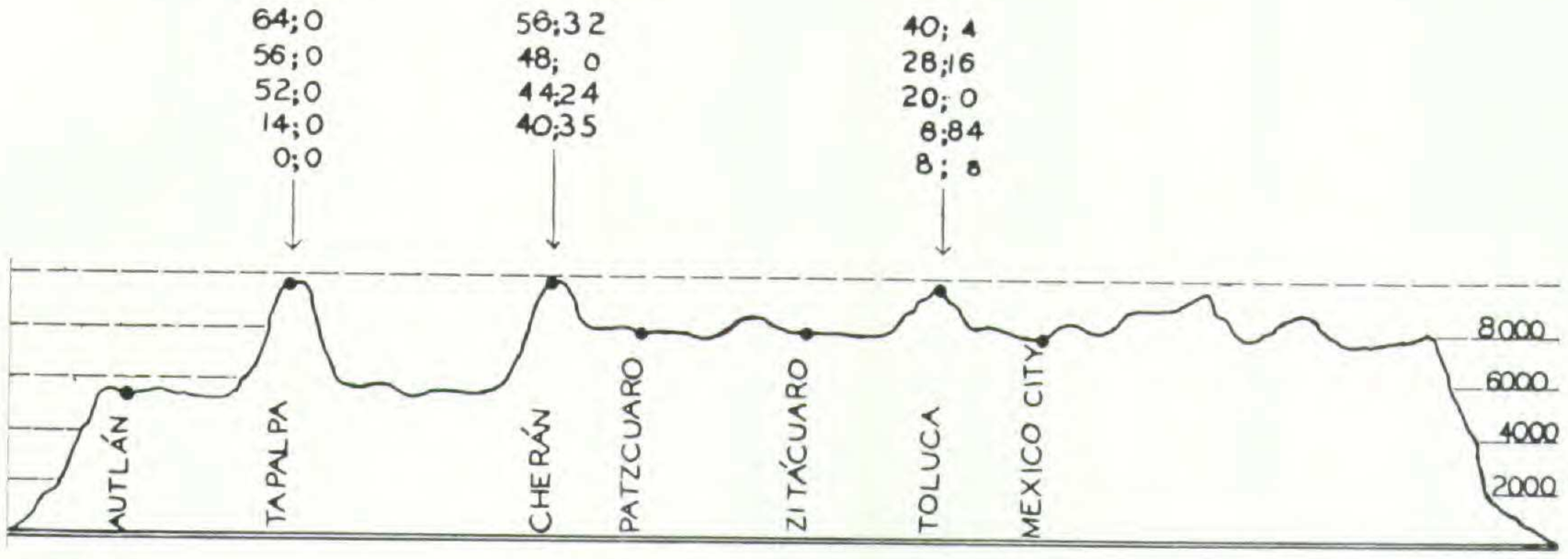


Fig. 5. Approximate cross-section from west to east through the area in central Mexico where most of these studies were made. Figures at the extreme right, elevation in feet above sea-level. For three mountain towns the per cent of each variety with ears enlarged at the base is shown above at left of colon, the per cent of pointed kernels at right of colon. It will be seen that percentages of enlarged bases increase from east to west and percentages of pointed kernels from west to east, on the average.

While the discussion has so far been limited to the evidence on kernel size and shape and on row number, many other characters are associated with this same gradient. The photographs of the Appendix show that the western Mexican extreme types have narrow, irregularly tapering ears which taper slightly towards the base as well as towards the tip. The varieties from central Mexico tend to have much shorter ears, many of which taper sharply to the apex and in an exact, almost mathematical fashion. From observations and collections in Mexico, as well as from progeny tests made at various points in the United States (Arcadia, Calif.; College Station, Tex.; St. Louis, Mo.; Johnston, Iowa; Blandy Farm, Va.), we know that there are correlated tendencies in the rest of the plant.

JALISCO	CENTRAL MEXICO
Long, narrow leaves with tough veins	Broad leaves with weak veins
More or less glabrous leaf sheaths	Very hairy leaf sheaths
Long, wiry tassel branches	Short tassel branches with densely arranged spikelets
Tassel branches, several to many	Tassel branches, several to few or none
Plant color, when conspicuously present, strongest along the veins and towards the base of the plant (strong R, weak b)	Plant color, when conspicuously present, strongest between the veins and above the ear shoot (strong B, weak r)
Strong root system	Shallow, weak root system

In other words, we have two extreme types of maize, one characteristic of western Mexico, the other of central Mexico. While the two extremes are so different as to be instantly recognized even as single individuals, they are connected by series of various intermediates. On the whole, the average intermediacy of a

population is proportional to its geographical position between the two different centers. Such geographically centered groups of correlated tendencies are characteristic of *Zea Mays*, and we have chosen to refer to them as "races" (Anderson and Cutler, '42), defining that term as "a group of related individuals with enough characteristics in common to permit their recognition as a group." The two races described above, while not the only major races in Mexico (see below), are by far the commonest. We have already designated the one from central Mexico as "Mexican Pyramidal" in reference to the short, and regularly tapering ears. It has also been recognized by Kuleshov ('30) in the report of the Russian expedition to Mexico as "Central Mexican Type." Kuleshov also referred to the other race described above as the "Narrow, long-leaved type." As a major race it probably extends all the way from the southwestern United States to the lowlands of South America. Until it has been more widely studied and more accurately measured it seems best to designate by name only that portion of it which has been accurately studied in western Mexico as "Mexican Narrow Ear."

The demonstration of a geographically oriented difference of this magnitude presents two questions: first, the theoretical one of how it originated and how it is maintained; second, the practical one of how to use it in making a natural classification (Anderson and Cutler, '42) of Mexican maize. A detailed discussion of the latter question will be deferred until some of the special varieties of Mexican maize have been described. For the first question there is fairly strong circumstantial evidence that the ultimate reason is historical; that these two races of corn were associated with different peoples and different cultures and that they once were even more distinct than they are now. Ultimately, of course, they must have had a common origin, but that problem is beyond the scope of this paper. However, even though there do seem to be historical reasons for the beginnings of these two races, their persistence must be due in part to differences in such factors as rainfall and altitude. The whole problem is much too complicated to be anything more than outlined here. Some of the most significant pieces of evidence are as follows:

1. The fact reported above, that varieties of very different positions on the gradient were sometimes grown in adjacent fields.

2. In a good part of Jalisco (see Appendix) the Mexican Narrow Ear varieties are referred to by a variety of names but are very commonly called "*maíz criollo*." *Criollo*, literally "Creole," used in this sense, means native or local, "old stuff belonging to this part of the country." In this same area intermediate varieties, however, are most commonly referred to as *maíz chino*. The word *chino*, literally "Chinese", is frequently used to indicate something foreign or peculiar. The common use of these two terms indicates that the 8-rowed varieties are the older sort and that the many-rowed, pointed-kernelled types are a later introduction. Though the latter are still much in the minority, their introduction is not a matter of just a few years. All the farmers with whom I talked assured me that "maíz chino" varieties were being raised in the locality when they were small boys (1890 to 1910).

3. There are various theoretical reasons for believing that when native varieties of popcorn are present they may represent the most primitive types of maize in that area. The native popcorn of western Mexico, *maíz reventador*, is like Mexican Narrow Ear varieties in everything but kernel size and its slightly higher row number. It has 12 to 14 rows but never the high row numbers of central Mexico. The native popcorn of the Mexico City-Toluca region, however, is vastly different and a typical "Mexican Pyramidal" variety. It is exactly like the small white dents of that region in every character except kernel size and texture. There is archaeological evidence to indicate that these two popcorns have been in their two respective areas for a considerable time. As has already been reported, Dr. Isabel Kelly has found charred remains of a corn at least very similar to *maíz reventador* in two excavations in western Mexico (Anderson, '44a). In Gamio's excavations at Teotihuacan (roughly from 1200 A. D.), just north of Mexico City, he found large masses of carbonized corn cobs and kernels which are on display in the local museum and which I was allowed to examine through the courtesy of the custodian. Measurements for the material are as follows:

Row number: 18, 18, 20
Kernel width in mm.: 4–7
Kernel thickness in mm.: 4
Kernel length in mm.: 8

Allowing for a little shrinkage in carbonizing they are exactly the same size and have the same shapes and row numbers as the popcorns and small pop-dents which are now being grown in the same region.

4. Among the most conservative and primitive Indian tribes of western Mexico are the Huichol who live in the steep-sided cañon region of Nayarit and adjacent states. The ethnologist Carl Lumholtz visited them in 1890 and collected a fine series of the varieties of maize used in their ceremonies, which are now in the American Museum of Natural History in New York. Three of the varieties are identical with those still being grown in the neighborhood of Autlán, the other differs only in its color (stippled aleurone). All are typical "Mexican Narrow Ear." Through the courtesy of the department of Archaeology I was able to measure these and the results are presented in fig. 6.

5. The differences between these races are inherent. When grown at various experimental fields in this country, these two extreme types were quite as conspicuously different as they are in Mexico. Both forms were somewhat abnormal when grown in the north, though mostly in different ways. The Mexican Pyramidal varieties often developed long ear branches. The Mexican Narrow Ear extremes have the capacity to develop tillers equalling the main stalk. In western Mexico these varieties are usually planted in the summer on account of the spring dry season, and only a few tillers develop. (In S. P. Tlaquepaque, Jalisco, I made a small experimental planting in the early spring and ascertained that Mexican

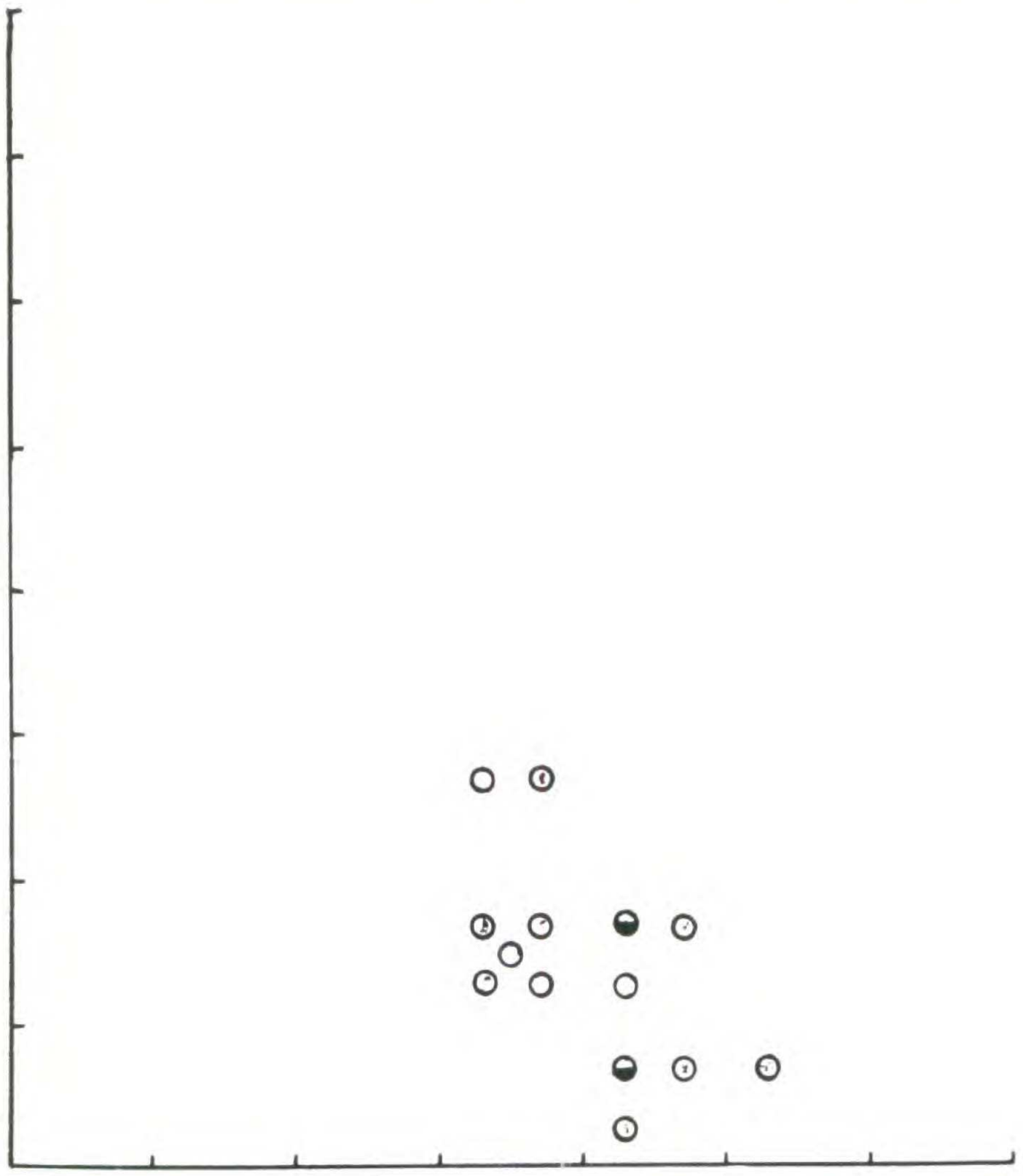


Fig. 6. Ceremonial corns collected among the Huichol Indians by Carl Lumholtz and now in the American Museum of Natural History in New York. Each circle represents a single ear (collection nos. 1889, 1897, and 1890). Scale of grid as in fig. 2.

Narrow Ear varieties would also develop many tillers if planted there at that season, though Mexican Pyramidal varieties did not tiller.) When planted in the north in the springtime, these western Jaliscan varieties tiller profusely. As a result of these two tendencies, these two races of Mexican corn look even more extreme when grown in the United States than they do in Mexico.

6. All the above evidence shows that the two extreme types have been in their areas for a long time and suggests that anciently the boundary between the two may have been sharper than it is to-day. There is some evidence, however, to show that ecological factors also play a role in keeping up the partial barrier between the two sorts. Between Autlán and Mexico City there is a general change in altitude and in climate pattern. The differences in amount and distribution of rainfall are probably a controlling factor. All of the large collections of corn which I measured in the plain and valleys around Autlán (Autlán,

Chachahuatlan, Tuxcacuesco, San Gabriel, El Grullo) were either specialty crops like *maíz dulce* (see below) or were typical Mexican Narrow Ear varieties. This is a region in which the scarcity of water has been a problem for a long time (Kelly, '45). Near by, in small clearings in the forested hills between Tuxcacuesco and El Limon, however, I made small collections of much superior, large-cobbed, many-rowed, deeply dented varieties (see Palmar in Table I and the Appendix). I was told locally that these varieties were grown back in the hills because there was more water available there.

Mountain Yellow

While the maize of the Mexican plateaus is varied as compared with that of the American Corn Belt, the variation becomes even greater as one ascends the mountains which rise above the plateaus. This maize of the mountains is so extremely variable from plant to plant and from field to field that it is difficult to discuss its general over-all tendencies. Collections were made in three such mountain regions and at about the same elevation in all three cases (fig. 5): (1) Toluca, just to the west of Mexico City; (2) Cherán in Michoacán; and (3) Tapalpa in Jalisco, on the northern flank of the great Volcán de Colima. In all three of these regions the corn was smaller-eared and shorter-statured than on the plateaus below. It was also more variable in pericarp color and with more red in the pericarp on the average. The percentages of pointed kernels were also somewhat higher. In the mountains one also finds a character which is very common in Guatemala though rare in most of Mexico: ears which are conspicuously larger at the base, giving them the over-all appearance of slightly tapering cylinders emerging from flattened spheres. Such ears are seldom seen on the plateaus. Around Guadalajara, Jalisco, for instance, at a general altitude of 5200–5400 feet there were twelve collections made. In eight of these there was not a single ear with a perceptibly enlarged basal region; there were two collections with 4 per cent and two with 16 per cent. In the mountains of Michoacán nine collections were made at elevations over 7000 feet with percentages from 32 to 80.

In spite of the variability of mountain corn and in spite of a general tendency for increased basal enlargement with altitude there is a very perceptible geographical trend in mountain maize from east to west. In central Mexico the mountain corns tend to be white, many-rowed, with pointed kernels. As one goes westward at equivalent elevations there is an increasingly great tendency for them to be yellow, few-rowed, and with an ear perceptibly enlarged at the base. This conclusion is supported not only by the detailed collections from the three areas referred to above but by much more maize which was seen but not measured, and by the large collections made by Beals in Michoacán and by Kelly in Jalisco. For Tapalpa, Cherán, and Toluca the measured collections yield the following information:

Locality	State	Per cent enlarged base	Per cent pointed	Prevailing color
Toluca	Mexico	40	4	Bright yellow
		28	16	Light yellow
		20	0	White
		8	84	White
		8	8	White-yellow
Cherán	Michoacán	56	32	Light yellow
		48	0	White
		44	24	Light yellow
		40	32	Light yellow
Tapalpa	Jalisco	64	0	Yellow
		56	0	Yellow
		52	0	White
		4	0	Light yellow
		0	0	Light yellow

TABLE II

This tendency to yellow-endospermed varieties with fewer rows and enlarged bases seems the more significant because this combination of characters is met with in Guatemala to an exaggerated degree. It seems likely that, in addition to the Mexican Narrow Ear and Mexican Pyramidal complexes of characters, there is a third complex much less strongly represented, which we may call "Mountain Yellow." Much more study will be required to demonstrate its presence and to analyze its historical and biological basis. From the facts at hand it seems to be connected with Guatemala in some way and in central Mexico to have spread from the west eastwards, at high elevations.

VARIETIES FOR SPECIAL PURPOSES

"Elote" Varieties (see pl. 7).—

In Mexico, as in the United States, much corn is used before it is fully ripe, either as corn-on-the-cob *(elotes)* or in various special dishes. Though native sweet corns are widely distributed in western Mexico (Kelly and Anderson, '43), they are not used for green corn since they are too gummy. Most of the common field corns are so used but there is also a widespread tendency to grow special varieties with colored (blue or red) aleurone for that purpose. This tendency is more clearly marked, and the varieties are more clearly differentiated morphologically from other local varieties, among the Tarascans of Michoacán (as has been reported by Beals, '46 [in press]). The *elote* varieties of this region are dark blue or black and are strikingly different in kernel size and ear shape from the field varieties there. They are not grown in the regular corn fields *(milpas)* but in small fenced enclosures close to the houses. In Jalisco the differentiation of *elote* varieties is not so extreme but it exists. In the town of S. P. Tlaquepaque, for instance, field corns are mostly white or yellow and are planted quite thickly in heavily ridged rows with an underplanting of squashes. The *elote* varieties are red (less frequently blue) and are ordinarily planted widely spaced in fields of peanuts. They are early-maturing and are harvested before the regular field varieties. In Tapalpa, Jalisco, on the northern flank of the great volcano of

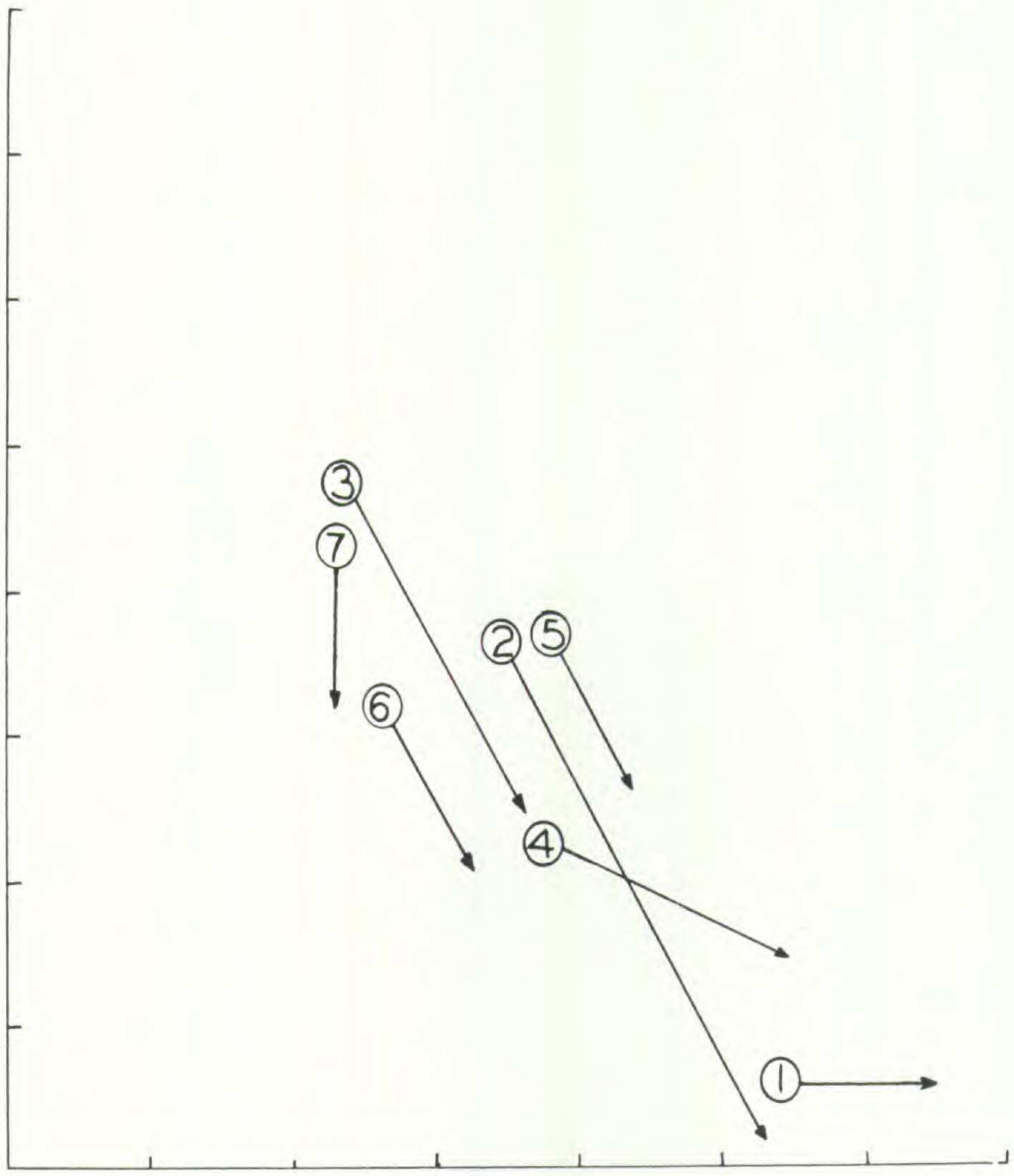


Fig. 7. Relation between the blue or purple "elote" corns and the common varieties of maize grown in seven different communities in various parts of Mexico. Grid for row number and kernel width as in fig. 2. In each case the circle with a number shows the average row number and kernel width of a common variety of maize growing near the "elote" variety. The position of the arrow shows the average row number and kernel width of the "elote" variety at that locality. Number 1, Tlajomulco (near Guadalajara, Jalisco); 2, S. P. Tlaquepaque, Jalisco; 3, Tlaltizapán, Morélos; 4, Uruapan, Michoacán; 5, Jiquilpan, Michoacán; 6, Patzcuaro, Michoacán; 7, Huehuetoca, Mexico. Number 2, for instance, indicates that the "elote" variety at Tlaquepaque had an average row number of 8 and an average kernel width of 14–15 mm. while the white corn grown by the same family had an average row number of 14 and an average kernel width of 10–11 mm. Further discussion in the text.

Colima, I was at first told that no special varieties were used for *elotes*. Description of the blue and red corns I had seen elsewhere brought out the fact that they were also grown in Tapalpa but on a very small scale. The local corn merchant himself showed me seed ears for his next year's crop of *elote* corn hanging in his own patio, though no stocks of this variety were stored in his big commercial granary.

Where they were grown these blue and red varieties were reported to be superior for green corn-on-the-cob, and for the production of various other maize foods such as *pinole* (Kelly and Anderson, '43). Inquiry as to why they were

grown usually brought out that they were sweeter or of a smoother consistency (*"son mas suave"*), and sometimes that they were earlier to ripen.

In the Tarascan country (Cherán and other villages near the new volcano) the *elote* varieties were so strikingly different morphologically from the other corn of that region that it seems as if they must have been introduced at another time than the field varieties or from a different region. In other parts of Mexico the difference is not so striking but there is the same general tendency for these varieties to have broader kernels and fewer rows than the ordinary field varieties. It would be difficult to be certain on this point from mere inspection, due to the great variability of Mexican maize. However, the method of recording the variation in an entire corn field, illustrated in fig. 2, allows us to make exact comparisons between *elote* varieties and field corns from the same localities. Figure 7 shows comparisons of the averages of the blue or red *elote* varieties in seven different communities with the white or yellow field varieties of the same communities. In cases where more than one field variety had been examined the one chosen was from the nearest field or was one grown by the same farmer. It will be seen that in each of the seven cases the *elote* varieties are more like Mexican Narrow Ear varieties. They are either fewer-rowed or broader-seeded or both.

To summarize: In Mexico special varieties of maize with colored endosperms are grown for use as green corn. These varieties are generally broader-kernelled and have fewer rows than the common varieties with which they are grown. There is a tendency to grow them in special plots. All these facts suggest that after maize growing was already established, there was the introduction of Mexican Narrow Ear varieties with colored aleurone for use as green corn. There is no evidence that this introduction was a recent matter and there are some indications that it may have been pre-Columbian. The habit is widespread; it is highly developed in little out-of-the-way towns with conservative habits, and similar varieties are used by the Huichol Indians in their ceremonies. This last fact is particularly significant since the Huichol are a conservative group living in a region isolated by high mountains and deep cañons. The collections of ceremonial corns described above were still being used when Lumholtz collected them, and they probably represent varieties which are very ancient in that part of Mexico. Two of the varieties collected by him, one a blue and one a red, are so similar to the *elote* varieties now being grown in Jalisco that they could not be separated out if the ears were mingled. Since the Huichol are in western Mexico and since the general trend in each locality is for the *elote* varieties to be more like extreme examples of Mexican Narrow Ear, it seems highly probable that these *elote* corns spread across Mexico long ago from the west and that they have since become more or less contaminated in each locality by the common maize of each region.

Cacahuazintle.—

One of the most distinctive varieties grown in Mexico is the kind called *Cacahuazintle* (literally, "ear of corn with a tough skin") in the region around

Mexico City. We have two collections, one from the valley of Toluca and another from the little Nahua-speaking village of Otlatlán in Puebla. In both ear and plant characteristics this variety is enough different from the other varieties of this region to be an obvious introduction. On the other hand, its Nahua name and its presence in this remote village suggest that its introduction is not a recent matter (see fig. 1, lower right two ears, and Appendix No. 71).

Cacahuazintle kernels are filled almost completely with soft starch, though some of the ears from Toluca and a majority of those from Otlatlán show indications of a more or less well-developed dent. Their kernels are large, nearly as thick as they are wide, and tend to be well distributed over the apex of the ear. I did not see the plants but was told in Toluca that they are of a different color from the common corn of that region and that they are taller and later to mature.

The ears of *Cacahuazintle* are so similar as to be almost identical with the Guatemalan variety known there as "Salpor", which in turn differs but slightly from some of the large-kernelled white flour corns of highland South America. *Cacahuazintle* is reported to be used commercially in the neighborhood of Mexico City for the manufacture of starch. In that region it is commonly prepared by swelling it in rapidly boiling water, and when so treated is considered as a kind of popcorn. While I never saw any specimens of it in western Mexico, its reputation had preceded it there, and I was several times told about the wonderful big popcorn of Mexico City which was cooked in boiling water.

The facts reported above are all in harmony with the hypothesis that *Cacahuazintle* spread into central Mexico from Guatemala or southern Mexico in pre-Columbian times.

The maize varieties of several Spanish-American communities in the American Southwest bear a suspicious resemblance to *Cacahuazintle* in their large white kernels. This is particularly true of some obviously mixed commercial varieties from Lower California and in the *"maíz del pais"*, which has been previously described (Anderson, '44b), from San Luis Obispo, California. It seems quite possible that a variety with kernels of this size and quality might have been widely scattered in colonial as well as pre-colonial times. A careful comparative study of *Cacahuazintle* and similar varieties should give us a more precise understanding of these relationships.

Maíz dulce (see pl. 8).—

These distinctive varieties, carrying the recessive gene for sweet, have been the subject of a special monograph (Kelly and Anderson, '43). It remains to point out here that although collections made in Jalisco show certain general resemblances to the other maize of that region, they also show a number of differences. They have more rows (the rowing is more irregular), the ears are shorter and are much more smoothly rounded at the butt. The kernels are smaller and the red color of the pericarp (due to various crown alleles of P) is not common in that region. A detailed discussion of these differences must be postponed until

such a time as the origin and dispersal of sweet corn in the New World is considered in detail. To clarify this survey of Mexican maize the following summary of the evidence may be inserted parenthetically. Recessive genes for sweet are known to have appeared as mutations at various times and places, and may well have occurred repeatedly in various parts of North and South America. The origin of the use of these distinctive mutations, however, follows a fairly simple pattern. It apparently took place in pre-Columbian South America as a source of sugar, before the introduction of sugar cane, sorghum, etc. Like the varieties of the region where they originated these primitive sweet varieties had "hand-grenade" ears, crowned pericarp, and many and irregular rows. They spread northward, gradually mixing with other kinds of maize, but protected somewhat by being recessives so that when careful seed selection was practiced, outcrossed kernels were discarded. In combination with the characteristics of the maize in which they originated, these sweet mutants were too gummy to be eaten as green corn. As the sweet varieties were gradually modified in their spread northward they eventually became watery enough to use as green corn, and were developed in this way among the North American Indians. The post-Columbian introduction of sugar cane reduced their importance as a sugar source and only in a few conservative areas (as in small towns in Jalisco or among the Hopi) have they been retained for their original purpose.

Popcorns.—

In addition to *cacahuazintle* (which is scarcely a popcorn by American standards) there are at least two popcorns in Mexico. They are grown in different areas and are associated with different races of maize. *Maíz reventador* (pl. 9), of the west of Mexico, is similar to Mexican Narrow Ear varieties in everything but kernel size and row number and is probably one of the ancestral sources of those varieties. It has been the subject of a special monograph (Anderson, '44a). The popcorns of Toluca are typical Mexican Pyramidal maize and are thoroughly amalgamated with the small white dents of that region (pl. 5). No natural boundary can be laid down between these small white, many-rowed dents and the small rice popcorns of the same regions. They are identical in plant type and they fade into each other from plant to plant and from field to field. A little denting is to be found in every crib of popcorn which I have examined, and hard, flinty, pointed kernels are a commonplace in the white dent corns of that region. Archaeologically these Toluca popcorns and pop-dents are interesting because they are identical in size and row number with the corn excavated by Gamio at the ancient pyramids constructed by the Toltecs in the valley of Mexico. Agronomically they are noteworthy as the probable source of the so-called Jap Hull-less popcorns to which they bear an extremely close resemblance in plant, kernel, and ear characteristics.

Discussion

There remains the discussion of certain problems in the light of this general survey of maize in central Mexico: (1) the practical question of how to describe and catalogue Mexican varieties of maize, (2) the origin of denting, (3) the genetics of multiple factor characters in modern maize.

(1) *The classification of Mexican maize.*—The question of artificial vs. natural systems of classification was discussed *in extenso* in the first paper of this series (Anderson and Cutler, '42) and need not be repeated here. It was pointed out there that the system usually followed (Sturtevant's) was almost purely artificial and that it was not very practical outside of the United States. A wholly natural system, however, if indeed it ever can be attained, is a goal to work towards rather than something which can be immediately set up in its complete form. We have therefore studiously avoided the use of Latin names and descriptions which would give our tentative and fragmentary attempts a more official status than they deserve. In the survey reported above we have attempted to demonstrate that the characters of Mexican maize are not distributed at random but are loosely associated in a few great complexes with marked geographical and altitudinal trends. The groups of varieties bearing these complexes of characters we have termed races, and while some fields show strong evidence of only one race, much of the maize of Mexico shows two or more in a single field.

For the practical business of describing and cataloguing Mexican varieties it would seem quite feasible to describe the typical "nucleus of common features" which typifies each race and then to indicate the preponderance of the various races in any one variety. When more than one race is evident in a variety, they should be cited in the order of their predominance. Races evident only upon close inspection should be cited within brackets. The varieties grown around Guadalajara, for instance, would mostly fall into Mexican Narrow Ear or Mexican Narrow Ear (Mexican Pyramidal). The varieties grown in Tapalpa would be classified as Mountain Yellow, Mountain Yellow (Mexican Narrow Ear), and Mountain Yellow (Mexican Pyramidal and Mexican Narrow Ear). When all the main races of maize in Mexico have been recognized and described it should then be possible to work out exact statistical techniques for assigning numerical values to the various racial components of any particular variety.

It is still premature to do anything more than suggest such a system. In addition to the races described above there are certainly others in Mexico. The varieties of the Tarahumare Indians need intensive study, so do the varieties of Oaxaca, Chiapas, and the east coast. Through the kindness of the Dirección de Agricultura y Fomentá and of Dr. E. J. Wellhausen of the Rockefeller Foundation I was able to measure and photograph collections from other parts of Mexico. From these collections it is clear that the highly derived varieties of the Pueblo Indians have spread down to northern Chihuahua and that some of the maize of the Mexican state of Chiapas is similar to that of

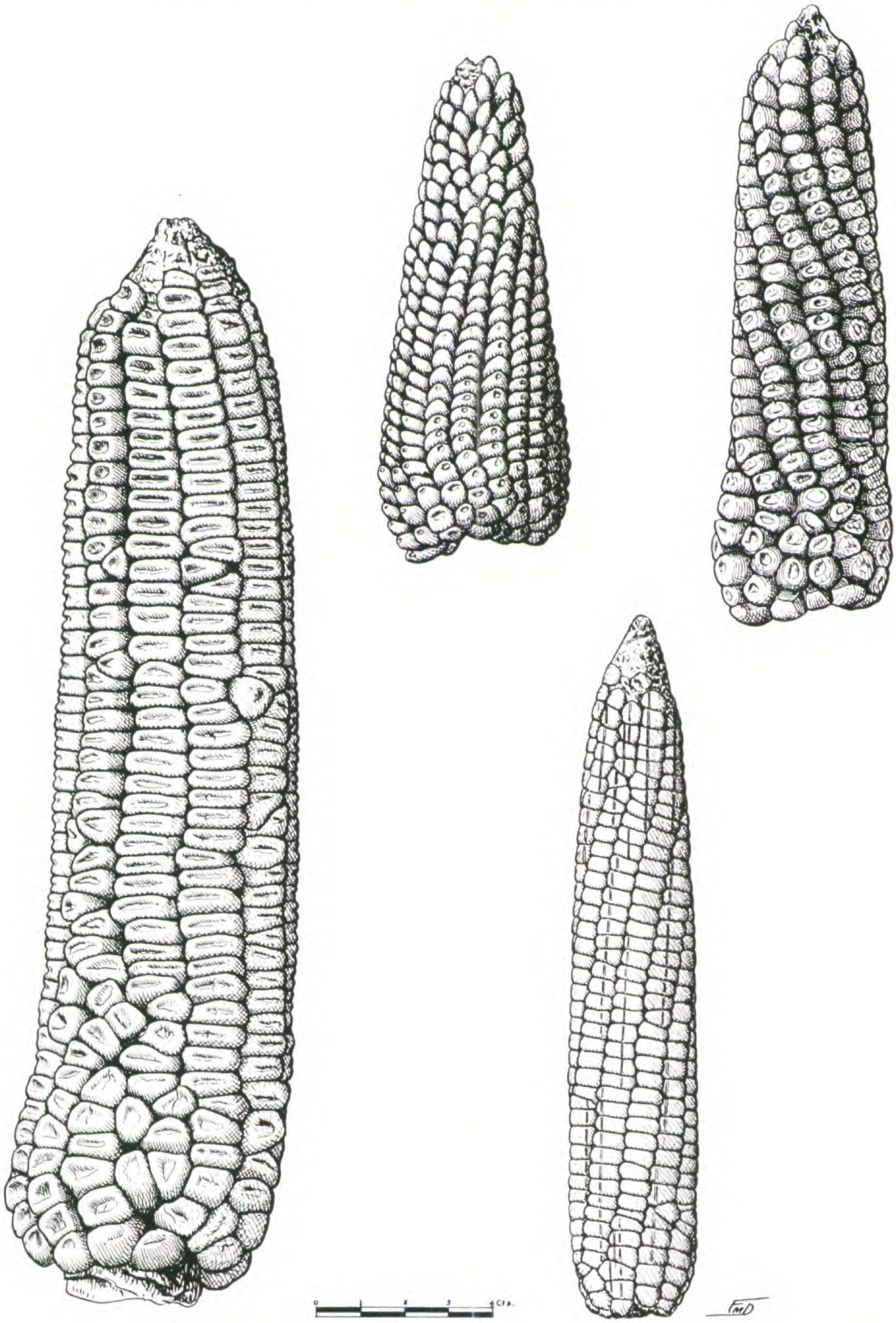


Fig. 8. Drawings showing racial extremes among the collections made in Mexico: upper right, an ear of "Mountain Yellow" from Tapalpa, Jalisco; upper center, "Mexican Pyramidal" pop-dent from Toluca; left, an ear from a field of *maíz ancho* at S.P. Tlaquepaque, Jalisco, which shows more indication of "Guatemalan Big Grain" than any other in that region. Collections from Chiapas showed a more enlarged base to the ear and a more regularly cylindrical upper portion. Lower right, *maíz chapolote* from Sinaloa, representing an even more extreme type than "Mexican Narrow Ear." Scale in cm.

adjacent Guatemala. The large shanks, enlarged base to the ear, and long ears of these varieties from Chiapas are a complex of characters found in somewhat diluted form in Mountain Yellow but of particular importance in Guatemala. Just as Mexican Pyramidal maize is tied up with the history of the Aztecs and their predecessors in the Valley of Mexico, so this Guatemalan complex is associated with the Mayas and their forerunners. As a convenience to students of Central American maize, the characteristics of these Mexican races are listed below in condensed form:

Mexican Pyramidal.—Found in purest form in the Mexico City-Toluca neighborhood. Plants short, highly colored, color characteristically interveinal (strong B, weak r). Plants with shallow root systems, leaves broad, with hairy sheaths. Tassels with few branches or none, condensation index very high. Ears short, tapering regularly, row number high to very high. Kernels more or less pointed, more or less dented. Endosperm prevailingly white, and yellow, usually pale, even when present (pl. 4).

Mexican Narrow Ear.—Apparently the common race of western Mexico, though variously modified locally by introduction and selection. The prevailing type in Jalisco up to 7,000 feet. Allied to such ancient varieties as *maíz reventador.* Plants tall, slender, from slightly to highly colored, color veinal (strong R, weak b). Stalks stiff, sheaths only slightly hairy. Tassel branches several to many, long and wiry, condensation index low. Ears narrow with small cob, long, irregularly long-tapered, compressed at butt and with long striation lines from tight husks. Row number characteristically 8 to 14. Kernels unpointed, slightly dented, if at all. Endosperm prevailingly white (all those tested have been *ccrr* [pl. 2]).

Mountain Yellow.—At high elevations. Found in purest form on the tableland north of the Volcán de Colima. From thence eastward, becoming progressively more mixed with Mexican Pyramidal. Endosperm bright yellow. Ears and kernels small, somewhat compressed. Ears distinctly enlarged at the base and with irregular rowing there (pl. 5).

Guatemalan Big Grain.—A characteristic Guatemalan type. Ears long with large, strong cob, firmly held on a big shank. Lower end of ear distinctly enlarged, upper part sub-cylindrical. In Mexico known in a pure form only from the State of Chiapas.

(2) *The origin of denting.*—The genetics of denting in maize has scarcely advanced beyond the point where it was left by the pioneer investigations of Hayes and East ('15). Whatever the origin of denting, its genetical background seems to be complex. The survey reported above demonstrates that in Mexico, denting reaches its most extreme development neither in the Mexican Pyramidal varieties nor in the Mexican Narrow Ear, but in kinds like *maíz chino,* which seems to be a mixture of both races. This assertion is no more than suggested by the figures of Table I, but in Mexico it is a matter of common observation that in traveling from western Jalisco to Mexico City one passes out of a region of undented or slightly dented Mexican Narrow Ear varieties into the variable but strongly dented varieties of the Bajio and eventually reaches another region of less denting, the Mexican Pyramidal center of pointed popcorns and pointed "subdents." This would suggest that denting is in some way associated with race mixture in maize. These results are in conformity with Jones' experimental evidence ('24). He crossed a pointed popcorn with a flour corn and obtained dented kernels in the second generation. It may be that in some manner not yet clear the dent corns of Mexico are hybrid derivatives of the pointed popcorns and the crescent-seeded flint and flour corns.

(3) *The genetics of multiple factor characters in maize.*—The survey reported above demonstrates that certain complexes of characters tend to be found

together in Mexican maize. Since all of the dent corns of the United States are derived from Mexican varieties, at least in part, we may expect to find some of these complexes still playing an important role in the maize of the United States Corn Belt. One who has studied character combinations in the cornfields and corn cribs of Mexico cannot walk through a modern breeding field in the United States without noticing the resemblances of certain widely grown inbred varieties to Mexican corn. The two inbreds, K43 and Illinois HY, for example, present combinations of characters that, while very different from the open-pollinated varieties from which they are derived, are almost identical with certain Mexican combinations. It has been shown from theoretical considerations (Anderson, '39), as well as by experimental test, that the total effects of specific and racial coherence are incredibly strong. If this be true in maize, we might therefore expect that our American dent corns would still be characterized by whole blocks of genes which tend to stay together because they came in together in Mexican white dents. If these complexes of genes still tend to be found together, on the average in American corn, then to understand and to analyze the genetics of multiple-factor characters in maize we shall have to pay attention to certain combinations of characters. In other words, the genetics of multiple-factor characters in maize has a good deal in common with *Oenothera* genetics. The complexes in *Zea* are probably much less loosely knit than they are in *Oenothera* and will therefore be more difficult to recognize and to locate in the germ-plasm. On the other hand, *Zea* is more completely analyzed genetically than any other plant. With concerted action it should eventually be possible to find which chromosomes carry the distinctive character combinations of Mexican Narrow Ear and Mexican Pyramidal, and then to use that information in maize breeding.

Summary

1. The great variability of Mexican maize is described. It varies from plant to plant in the same field, from field to field in the same locality, and from region to region. For the first two of these categories the variation is like that in the United States but greater in magnitude; the regional variation is beyond anything encountered in the United States.

2. The customary pigeon-holes of maize agronomists (dent corns, popcorns, flint corns, etc.) are shown to be inefficient and misleading in Mexico.

3. It is argued that in classifying a variable, cross-pollinated crop like maize the population is a more significant unit than the individual.

4. A method of measuring and describing maize populations (fields) is developed and applied to the collections made in Mexico.

5. By means of this method the association and geographical distribution of high row number with narrow, pointed kernels is analyzed.

6. Other characters are shown to be associated with these trends in row number and shape of kernels. High row number, pointed kernels, wide, hairy leaves, condensed tassels, constitute a complex characterizing the Mexican Pyramidal race.

It is centered in the state of Mexico. Low row number, long, irregularly tapering ears, wide kernels, narrow leaves, long, wiry tassel branches, form a complex characterizing the Mexican Narrow Ear race of western Mexico.

7. The available evidence suggests that the ultimate reasons for these different races are largely historical but that their persistence in modern times is in part due to their adaptation to different areas.

8. Evidence is presented for the existence of a third race, Mountain Yellow. It resembles Guatemalan maize, is restricted to high altitudes, and from Jalisco eastwards to Toluca becomes increasingly mixed with Mexican Pyramidal.

9. Several varieties grown for special purposes are described in detail:

A: Varieties with colored aleurone used as green corn. They apparently spread from western Mexico in ancient times and have become more or less mixed with the common varieties of each region.

B: A large-kernelled flour corn known as "Cacahuazintle" apparently derived from the "Salpor" variety of Guatemala.

C: *Maíz dulce*, whose significance in the history of American sweet corns is briefly indicated.

D: The ancient popcorn of the west coast, *maíz reventador*, and the very different rice popcorns of the state of Mexico.

10. Three general problems are discussed in the light of the above survey: the classification of the maize of Mexico; the origin of denting in maize; and the genetics of multiple factor characters in North American maize.

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Explanation of Plates 2 to 9

Most of the photographs in these plates are due to the energy and foresight of Prof. Carl Sauer, of the Department of Geography of the University of California, who not only assembled a significant collection of Mexican maize but saw to it that it was expertly photographed. The negatives are now the property of the Museum of Anthropology of that institution, and I am indebted to Mr. E. W. Gifford for permission to use them here. The ears illustrated in pl. 5 and the lowermost ear in pl. 4 are from my own collections; the remainder were collected by Dr. Isabel Kelly. All are reproduced at a little less than natural size.

Plate 2. Three ears of Mexican Narrow Ear varieties. Left to right: from Ameca, Tuxpan, Tuxpan.

Plate 3. Four ears of Intermediate or *maíz chino* varieties. From top to bottom: from Sayula, Ameca, Sayula, Ameca.

Plate 4. Four ears in which the Mexican Pyramidal influence is predominant. The top three ears are from Nochistlán, Zacatecas. The bottom ear is from Tlaltizapán, Morelos. It is an extreme example of the variety known as *pipitillo* which is favored by corn merchants because it shells readily and produces a maximum volume for sale by the litre.

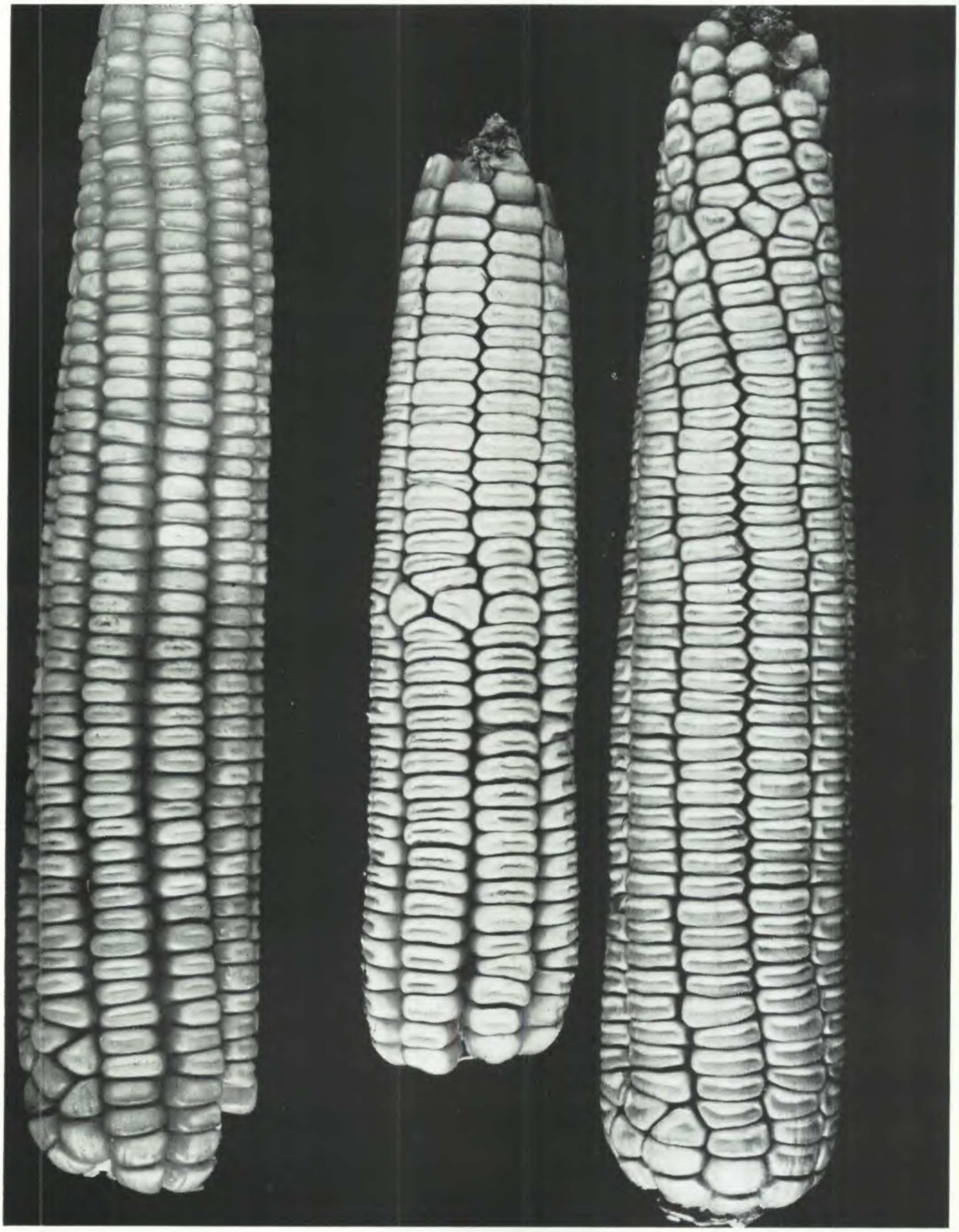
Plate 5. Five ears from high altitudes, showing Mexican Pyramidal influence. The three to the left are from the village of Tlacotepec near Toluca. The two smaller ones show strong evidence of mixture with Mountain Yellow. Right above, with black background, the common popcorn of Toluca (see Appendix, fig. 55, for further data). Right below, ear of an early-maturing purple variety from Acupula near Tepotzotlán, a few miles north of Mexico City. It is Mexican Pyramidal with a strong indication of Mexican Narrow Ear in the compressed butt, husk striations, lower row number, and plant type (See Appendix No. 64).

Plate 6. Four examples of Mountain Yellow from Tapalpa, Jalisco, on the northern flank of the Volcán de Colima.

Plate 7. Three examples of "elote" varieties with colored aleurone. The two to the left are from Unión de Tula, Jalisco; the one to the right is from Ameca. Note the single white seed, which probably indicates pollination with dominant white (C^i).

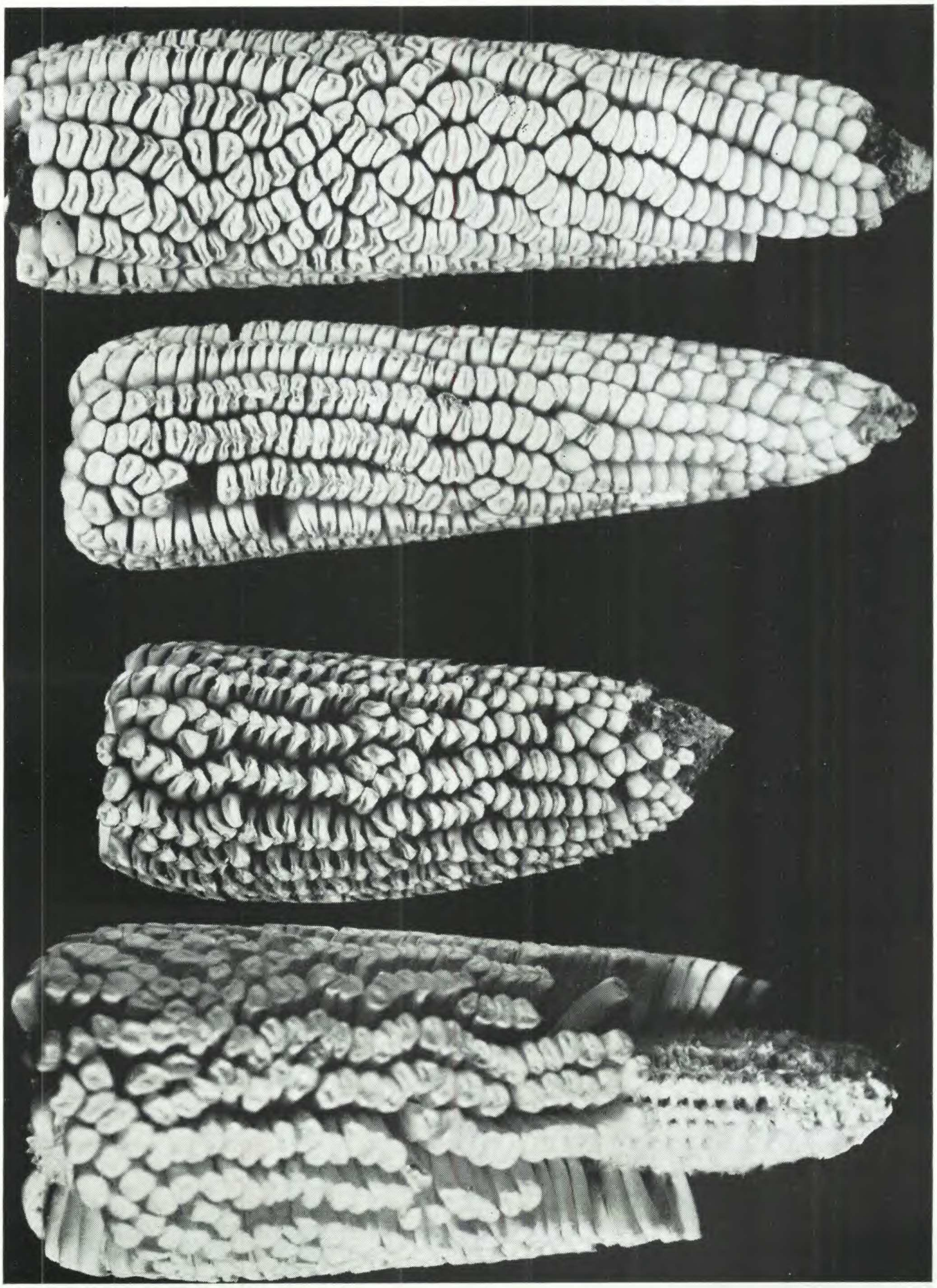
Plate 8. Two ears of *maíz dulce*, a primitive source of sugar, from Unión de Tula, Jalisco.

Plate 9. Two ears of *maíz reventador* from Tuxcacuesco, Jalisco (badly damaged by insects) and one from Sayula, Jalisco. Lower right, two ears of *maíz chapolote* from an *ejido* near Culiacam, Sinaloa, Mexico.

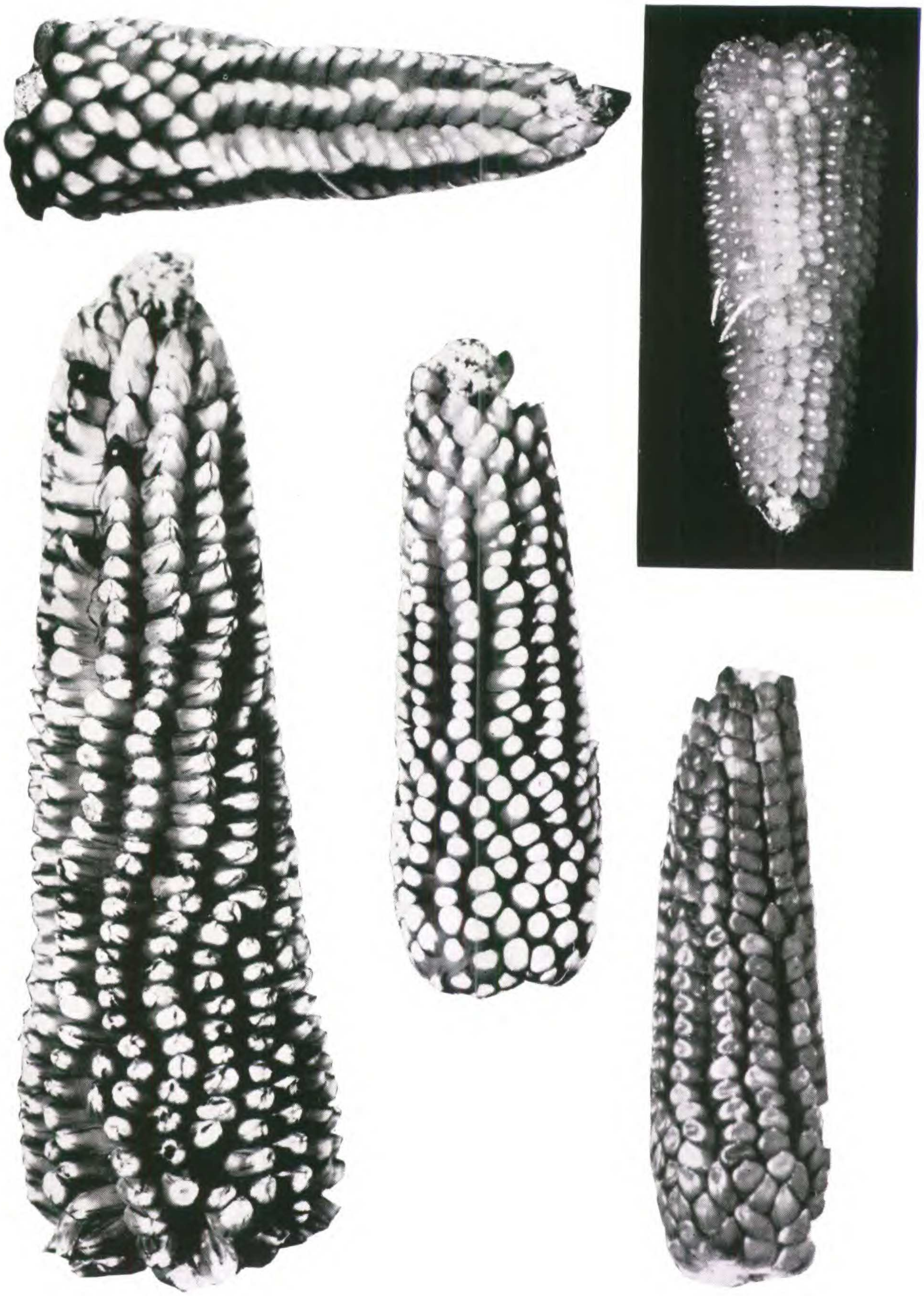


MEXICAN NARROW EAR

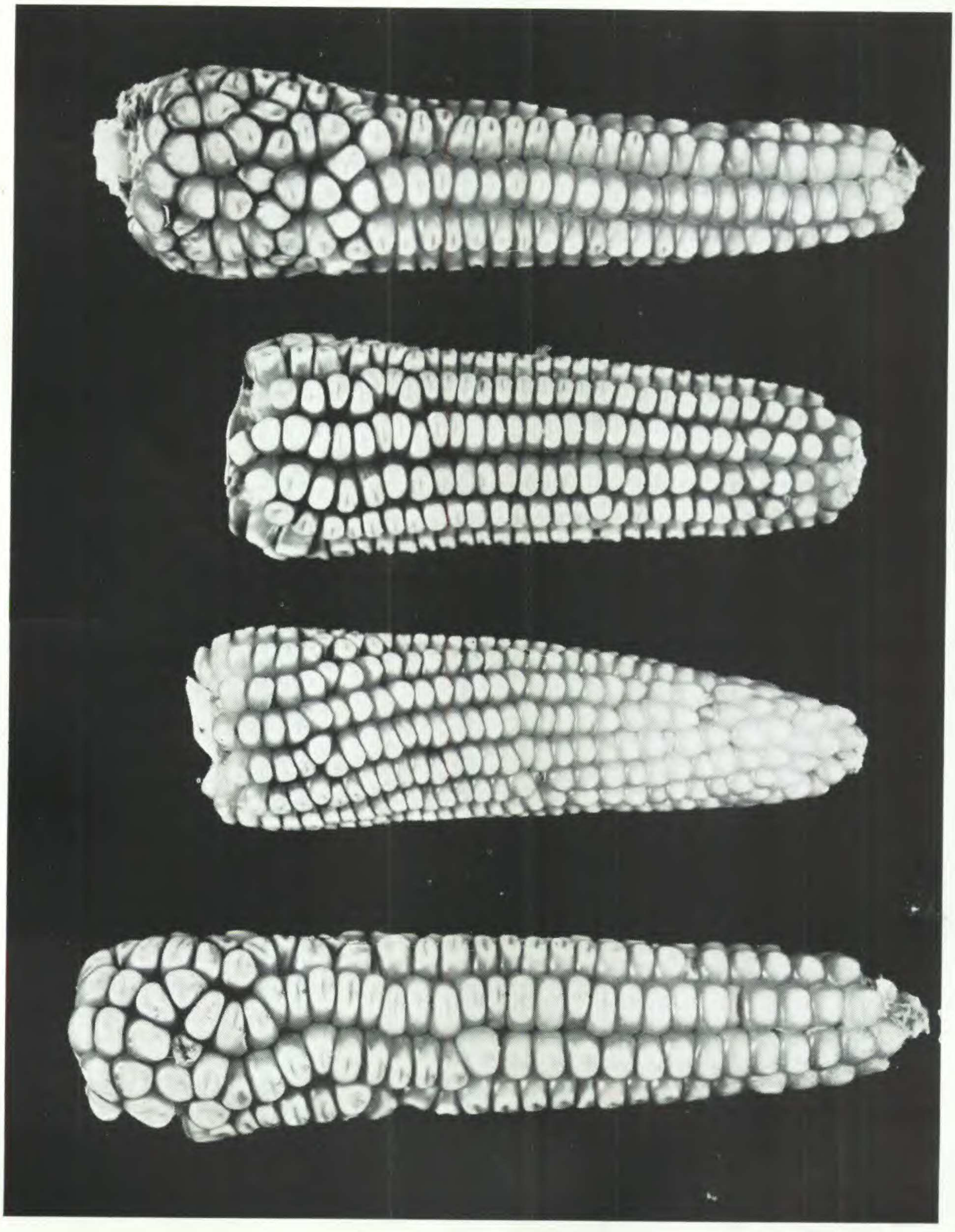
INTERMEDIATES



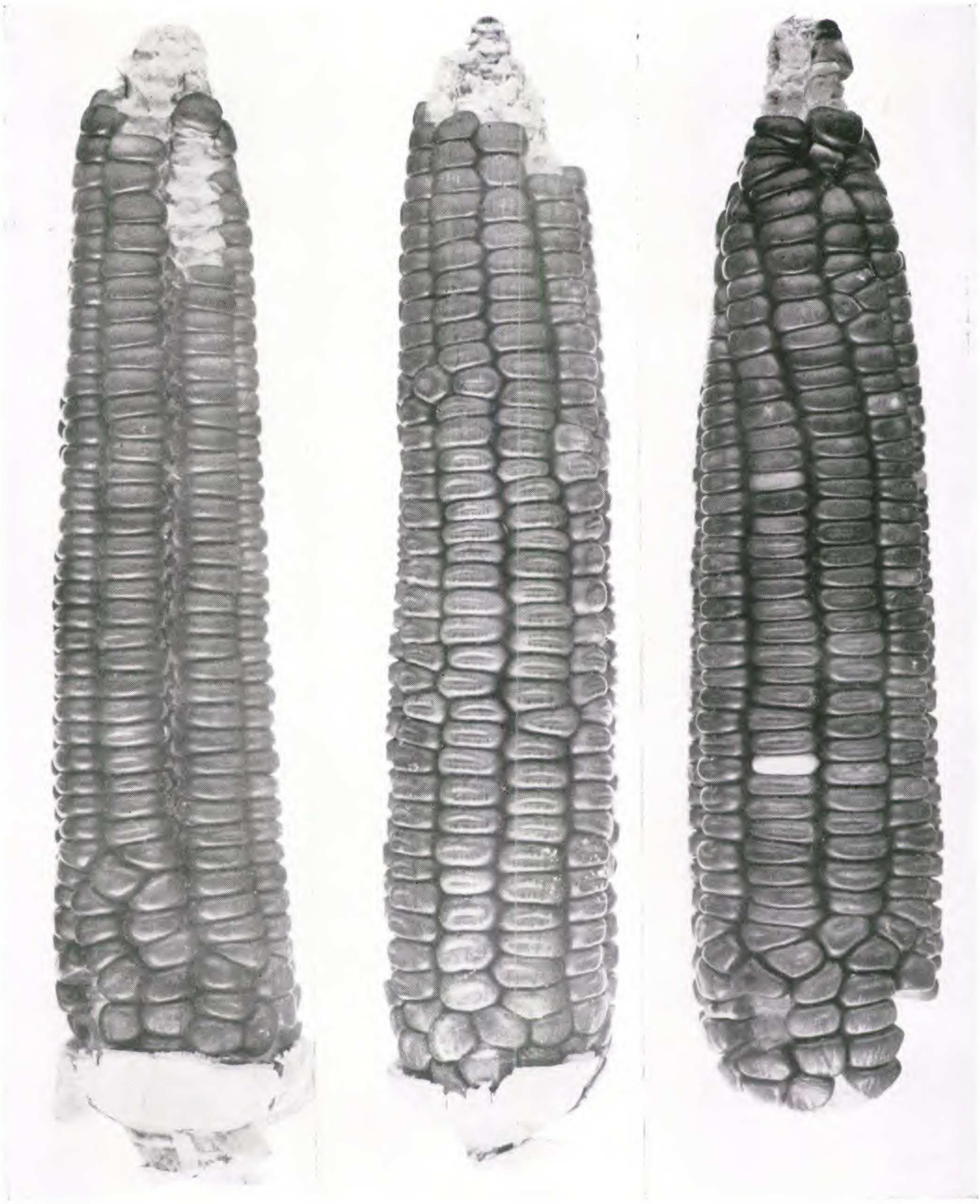
MEXICAN PYRAMIDAL FROM LOWER ALTITUDES



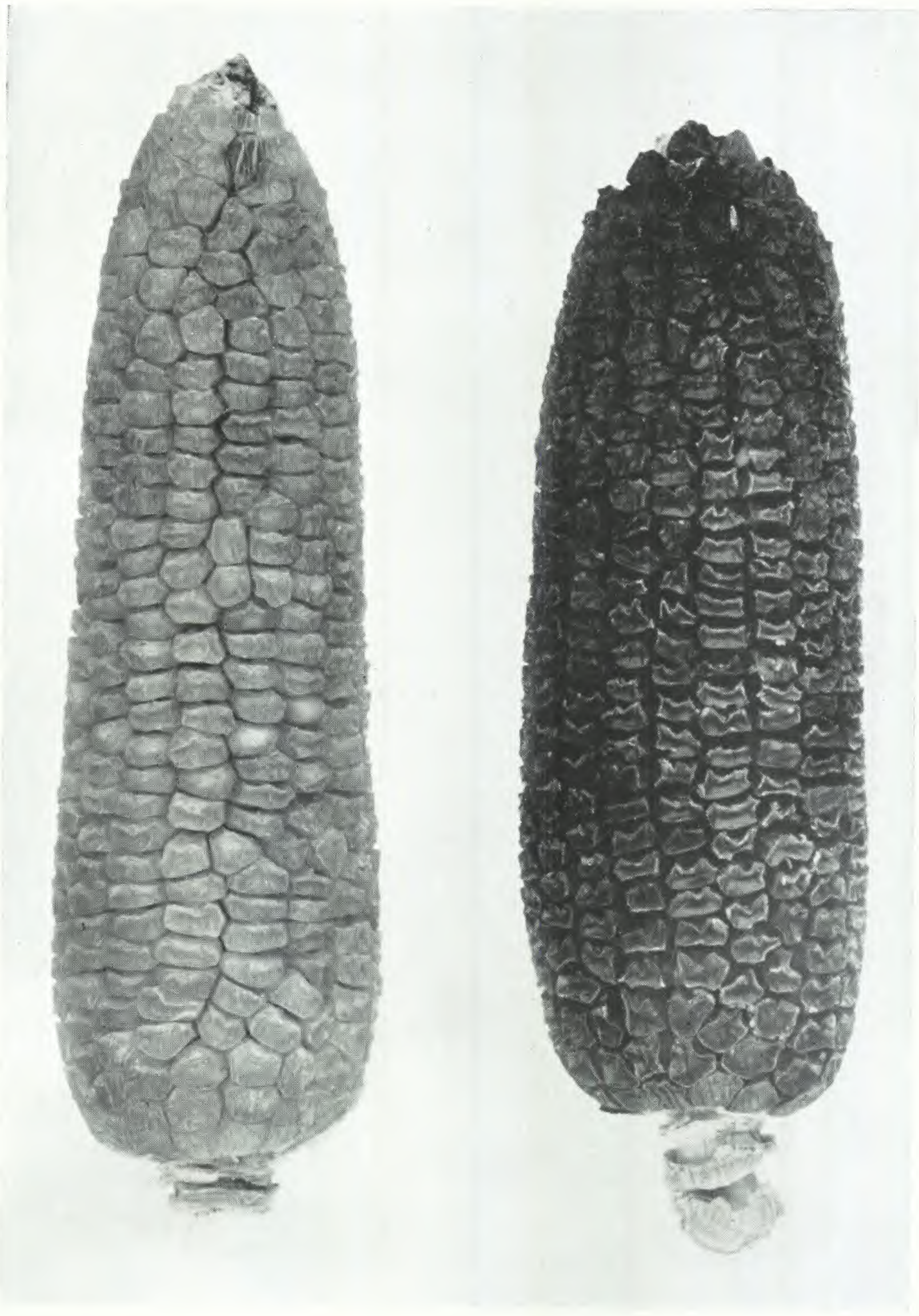
MEXICAN PYRAMIDAL FROM HIGHER ALTITUDES



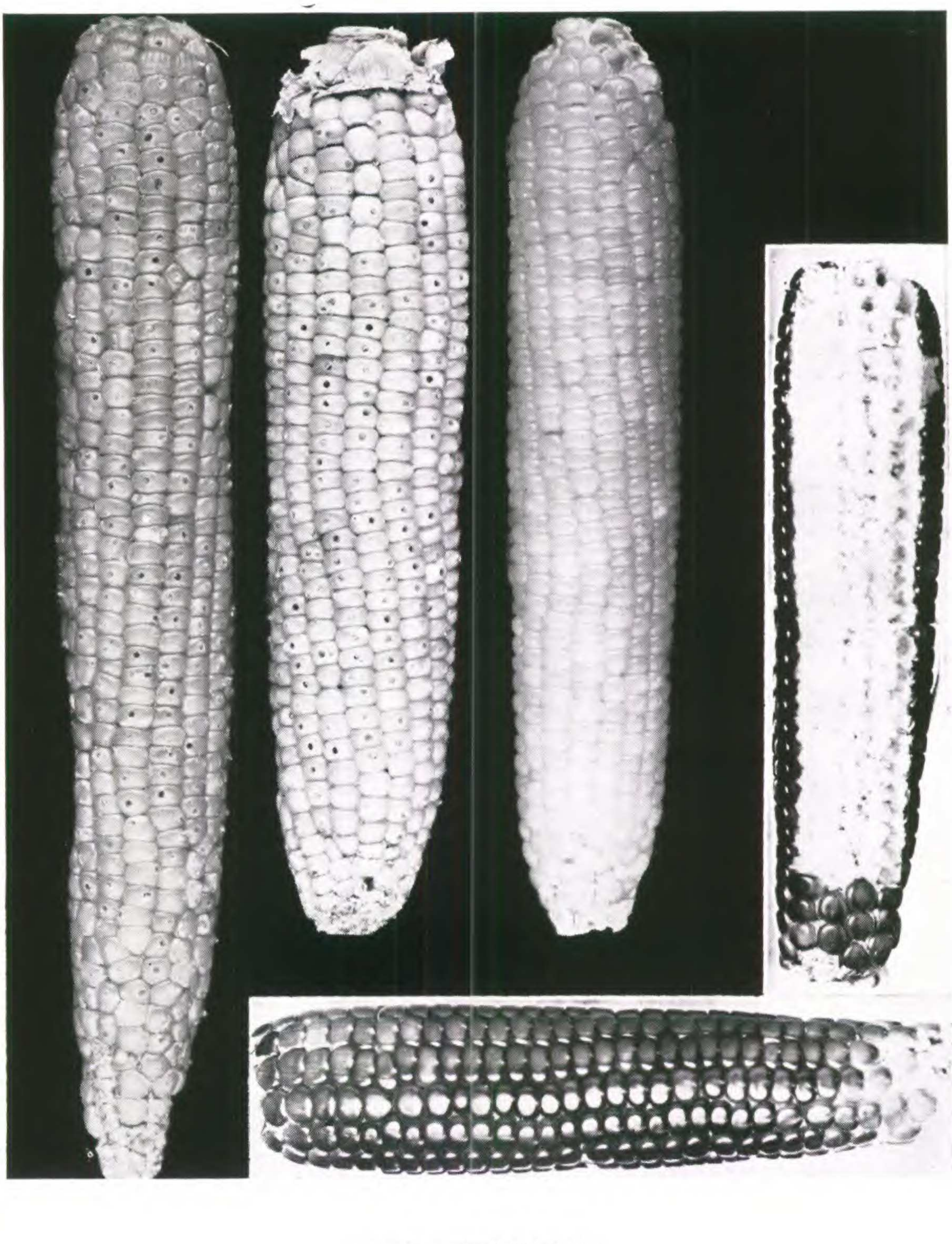
MOUNTAIN YELLOW



ELOTE VARIETIES



MAIZ DULCE



MAIZ REVENTADOR

Maize Collections from Mexico

FOREWORD

The following records and photographs are an attempt to sample and record the common, every-day corn of Mexico. Much of it is from villages off the highway and the railroad; of the 72 samples only two represent the finest corn which could be raised in that particular vicinity. Varieties of spectacular productivity can be, and are, grown in Mexico; in this survey they were rather deliberately avoided. The old-fashioned varieties of the small growers give a clearer picture of what indigenous Mexican maize was like before its variation pattern had been blurred by modern commerce.

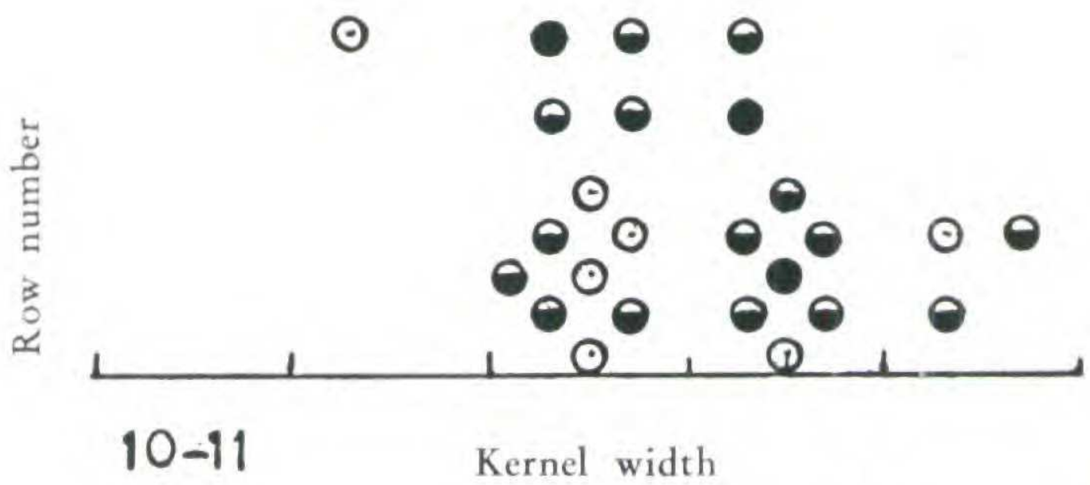
The grid used in each diagram has been explained in fig. 2 of the paper to which this is an appendix. Row numbers from 8 to 22 are diagrammed on the vertical axis at the left; kernel widths in mm. are diagrammed on the horizontal axis across the base of the diagram. The first division of the scale represents 4–5 mm., the second 6–7, and so on up to 16–17 at the right. The same grid to the same scale has been used throughout. For a few of the collections with very wide kernels only the right-hand end of the scale is represented. The vertical scale (though not drawn) is the same as in all the other diagrams and can be obtained by measurement. The horizontal scale begins at 10–11 mm. instead of at 4–5 mm. and is so indicated in each diagram.

It might be well to point out that although these grids resemble the scatter diagrams made in preparing a correlation table, they are a cruder device. They are nothing but a set of pigeon-holes classifying all the ears of maize simultaneously according to row number and kernel width, and diagramming their denting and kernel pointing in a graphic manner. The ears that fall in each square (each separate pigeon-hole, that is) are diagrammed as close to the center as is practicable; the arrangement within the square has no significance.

The photographs are all snap-shots made with a Leica camera. All but one have been printed to the same scale. Most of the pictures include the calipers used in making the measurements, and in each case the calipers were set to exactly 5 cm. In so far as possible the ears which are photographed represent a random selection from the field or crib. Where local pride prevented the illustration of a typical sample, this has been indicated in the notes.

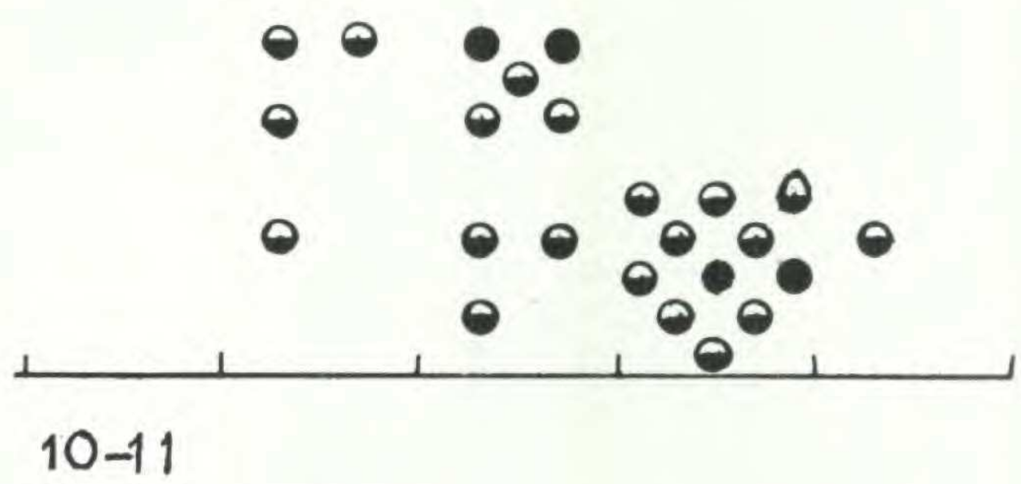
Kernel color was scored separately for each ear that was measured, and the summaries below each picture are an exact digest of accurate notes. Cob color was not recorded in so systematic a fashion, and the lack of any mention of red or purple cobs is no indication that they were not present in the sample.

For a variety of reasons the Appendix does not exactly coincide with the collections reported in Table I but in general the collections are represented in both places. In the Appendix, as in the table, the collections are arranged according to Mexican states and roughly from west to east within each state. They were mostly made on the plateaus of central Mexico and the lower flanks of the mountains which rise above these plateaus. Aside from a few scattering collections from other parts of Mexico they are from a region about 300 miles in extent, from a little west of Guadalajara to the vicinity of Mexico City.



1. Autlán, Jalisco. *Maíz criollo*

From a small grower at the edge of town. Prevailingly white though a majority of the ears had a few yellow kernels and a few ears had many. One ear had a tan pericarp and one had four kernels with colored aleurone, three of which were *pr*, and one *Pr*. Horizontal scale shifted to the left (as indicated) to accommodate wide kernels. Vertical scale as in No. 4.



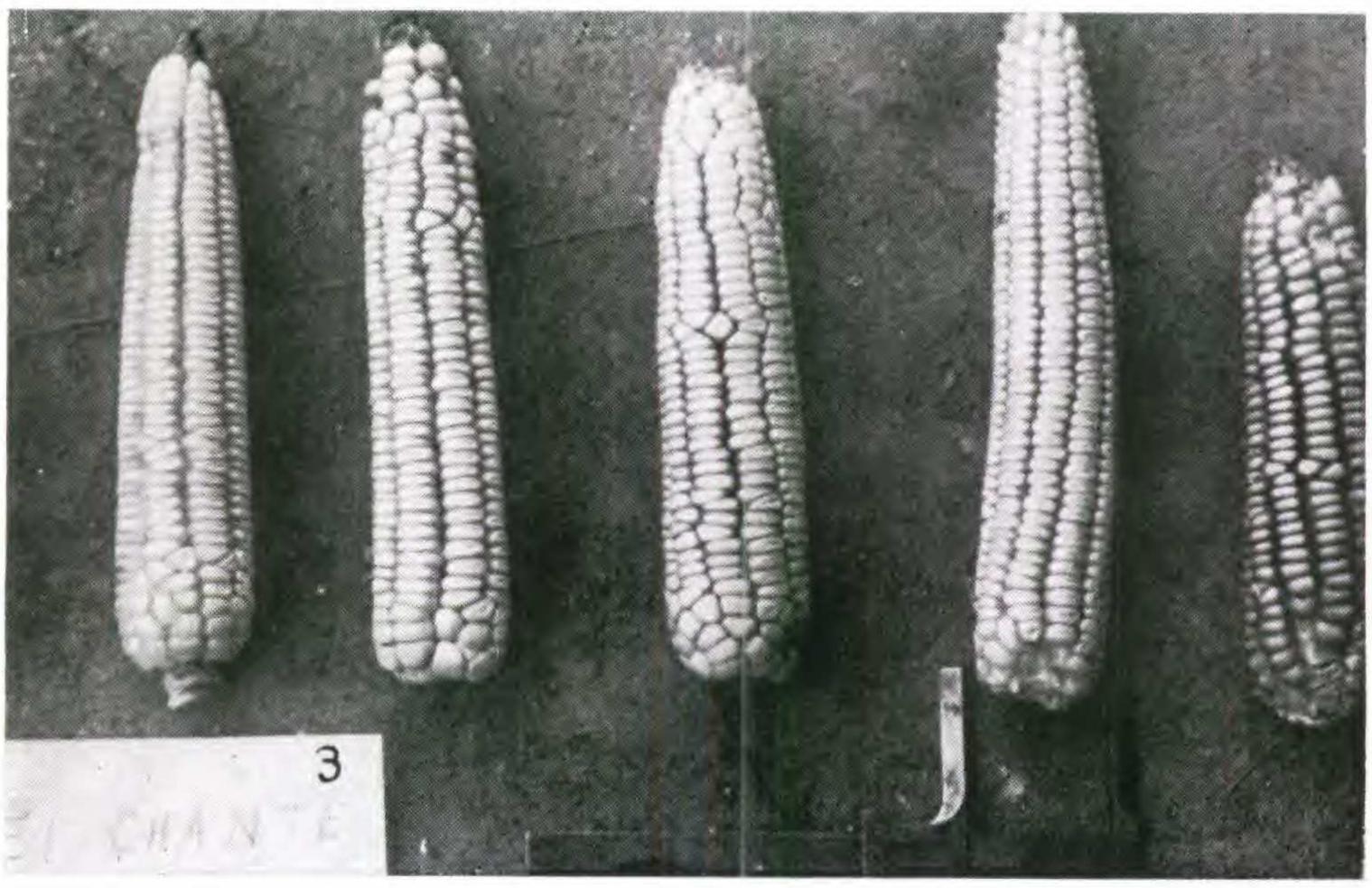
2. El Grullo. *Maíz humiado*

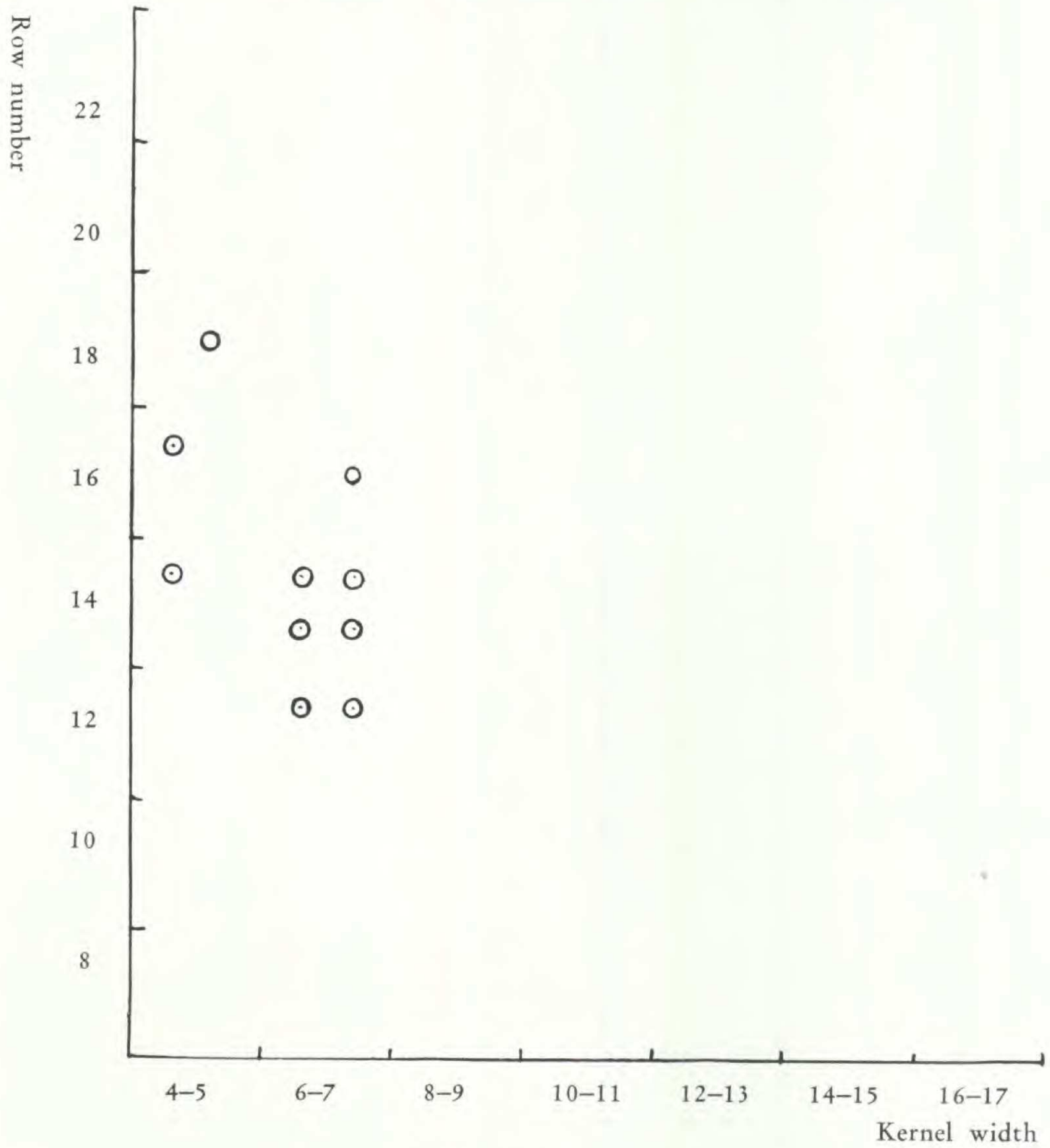
The name (literally "smoked") refers to the tan pericarp which characterized all but eight of the ears. Probably most of these also exhibited this character but in too dilute a state for recognition without dissection of the pericarp. Over half the ears had at least a few kernels with yellow endosperm. One ear bore a single kernel with colored aleurone *(Pr.)*. Horizontal scale as in No. 1; the vertical scale, though not shown, is the same in the first three collections as in those that follow.

10 -11

3. El Chante, near Autlán, Jalisco. *Maíz humiado*

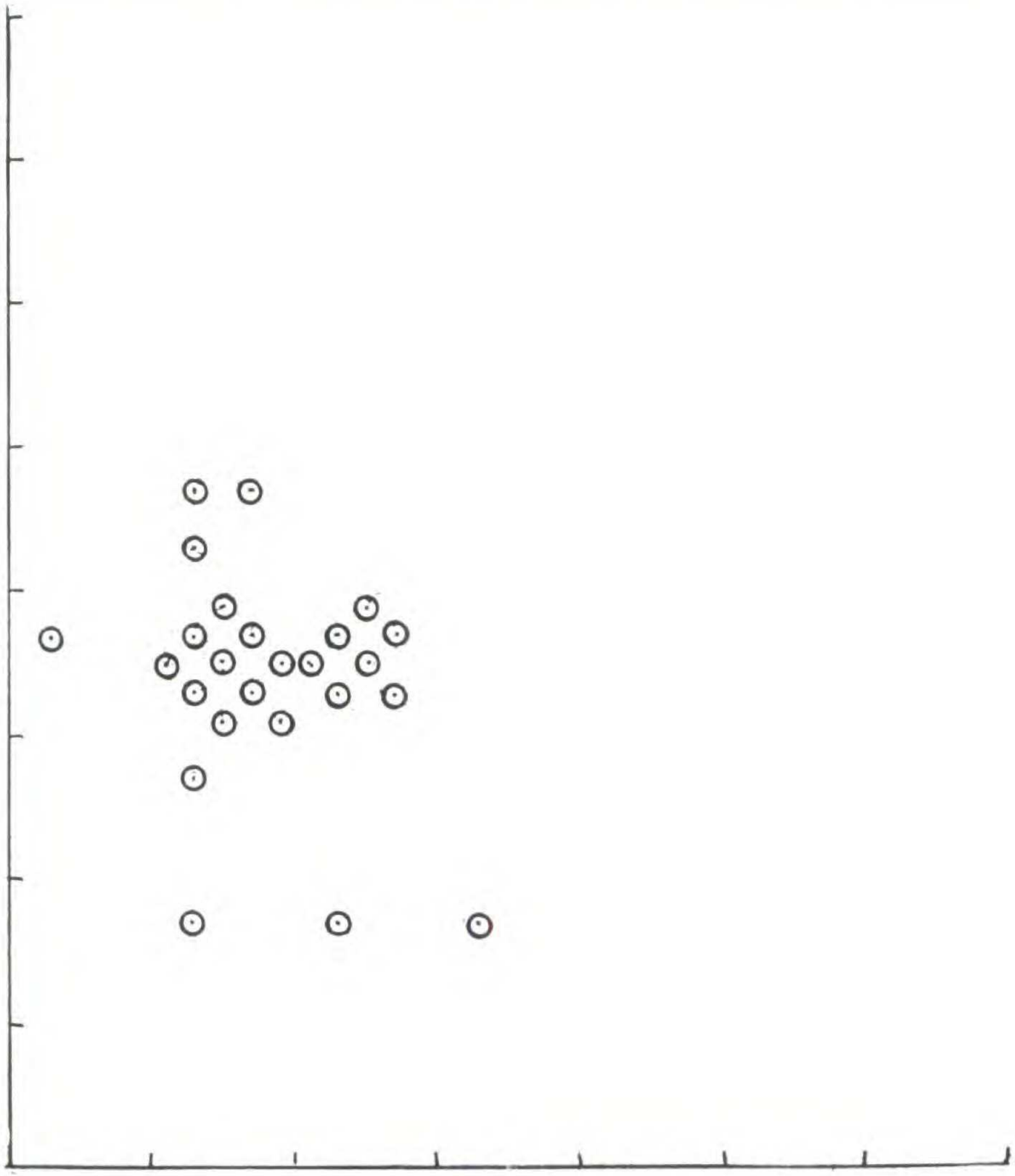
A sample of thirteen ears obtained for me by Don José Maria Corona. Very similar to No. 2.





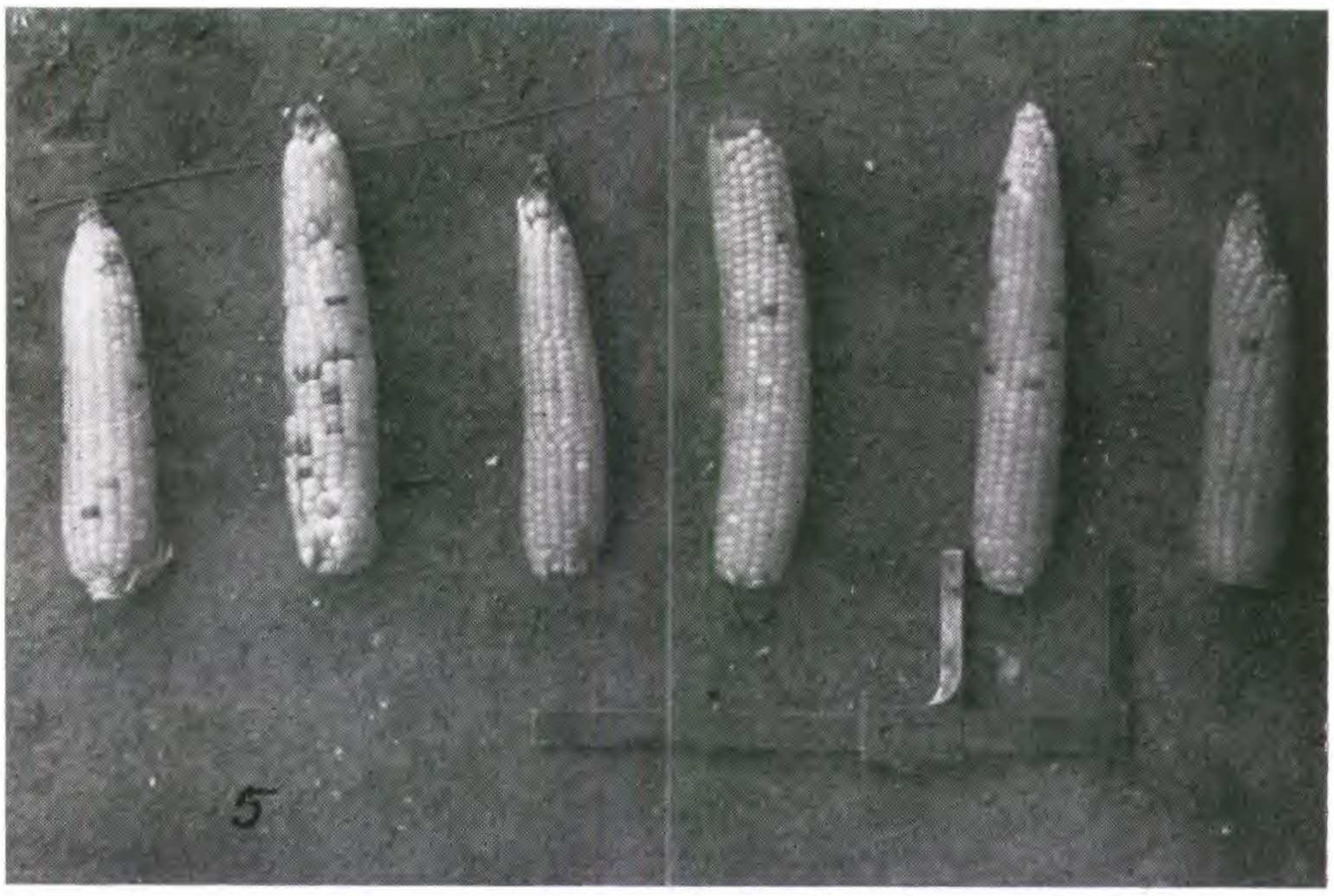
4. El Limón, Jalisco. *Maíz reventador*

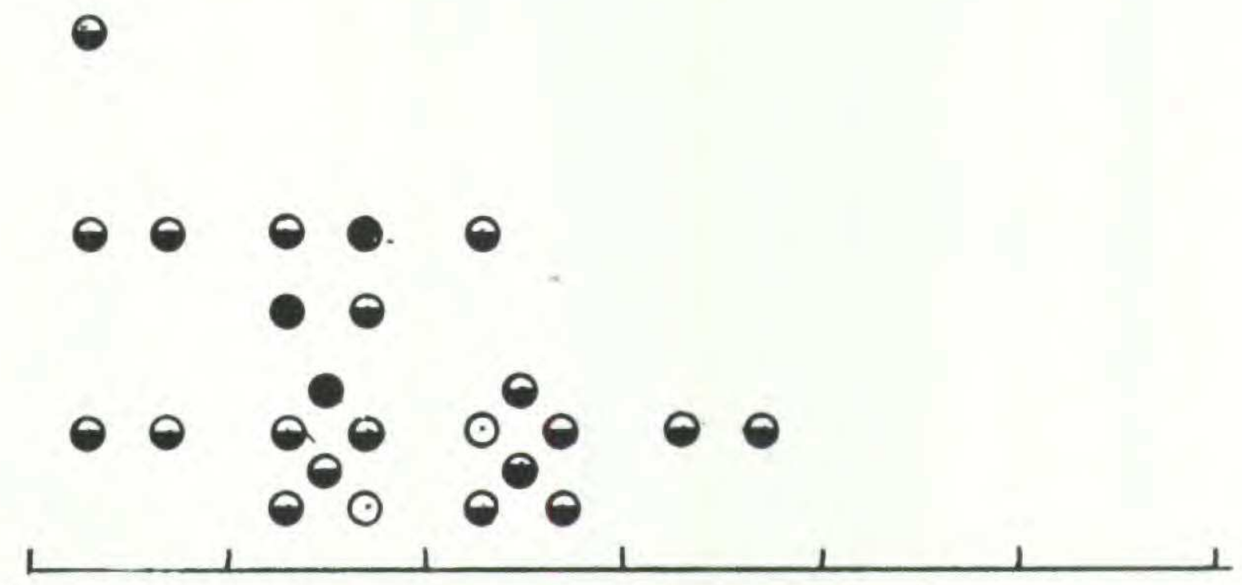
A sample of ten ears abtained by Don José Maria Corona. Prevailingly white. The few colored kernels were all *pr.* Ears similar to those shown in pl. 9 and in the following collection. Scale as in fig. 2. Vertical scale: row numbers from 8 to 22; horizontal scale: kernel width from 4–5 to 16–17 mm.



5. Chachahuatlán, Jalisco. *Maíz reventador*

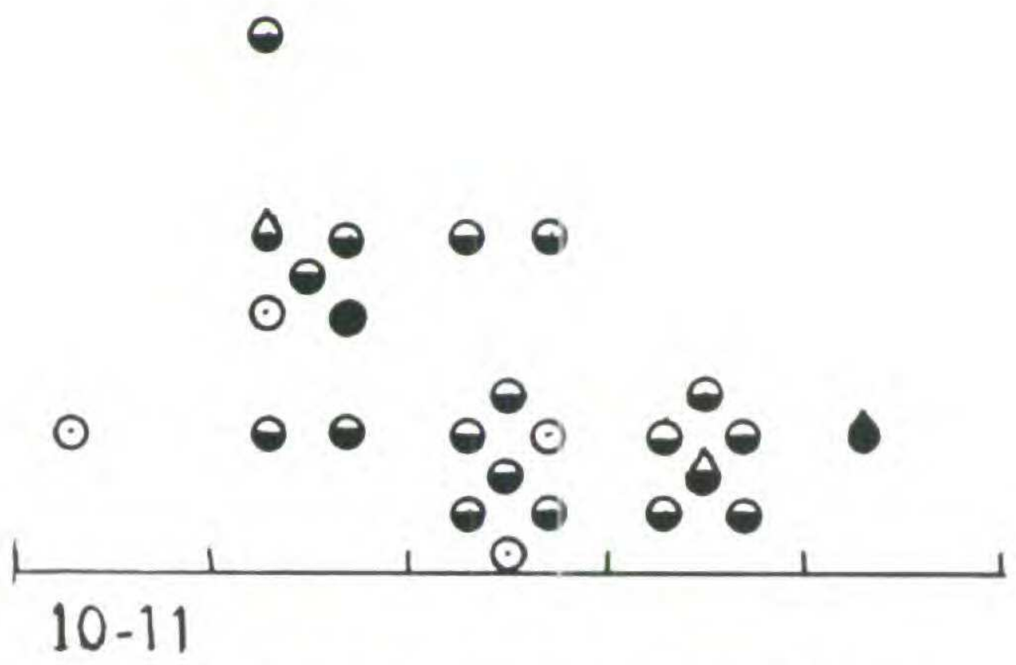
Maíz reventador, the ancient popcorn of western Mexico, has been the subject of a special monograph (see Bibliography, Anderson, '44).





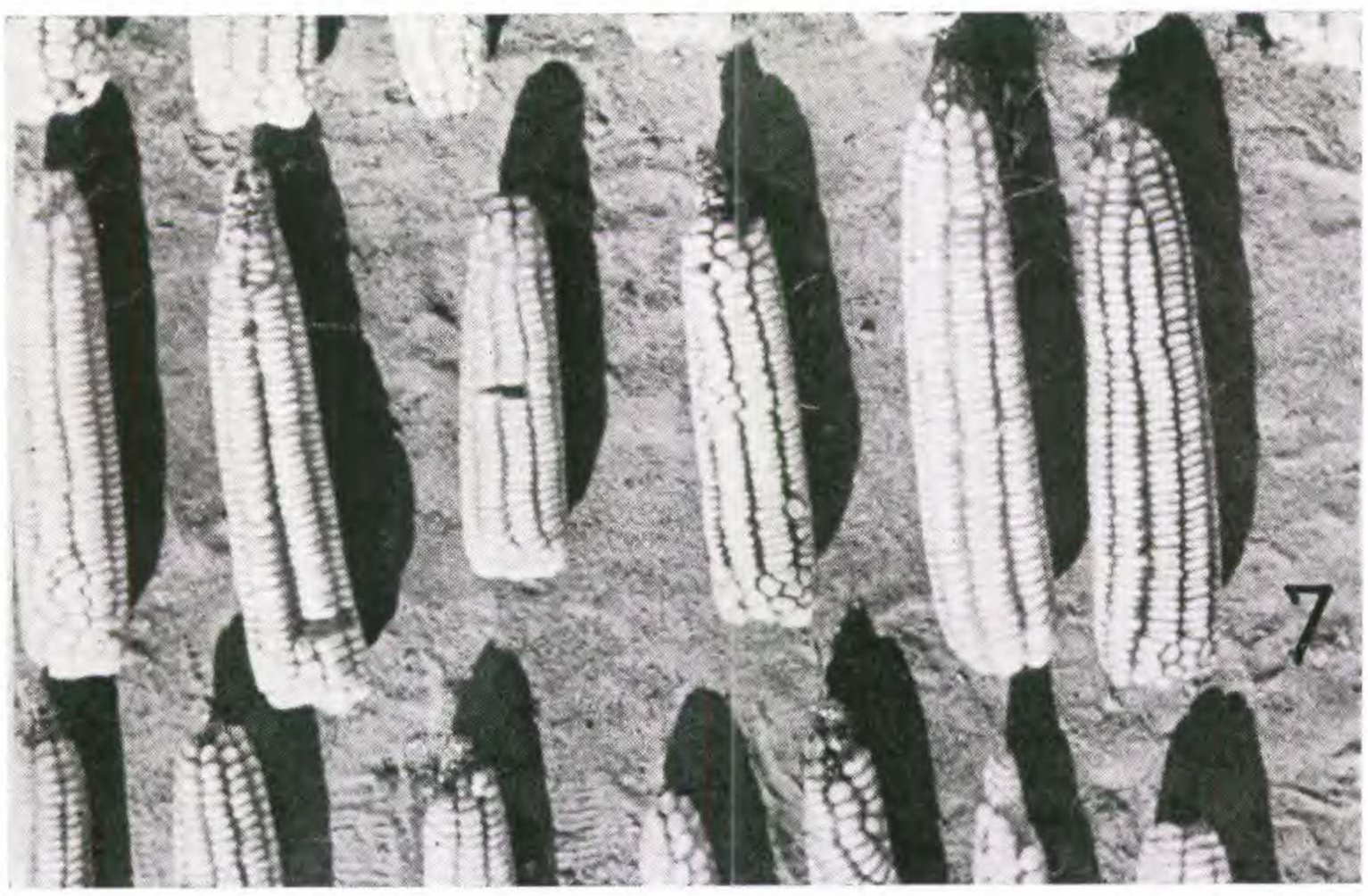
6. Chachahuatlán, Jalisco. *Maíz colimote*

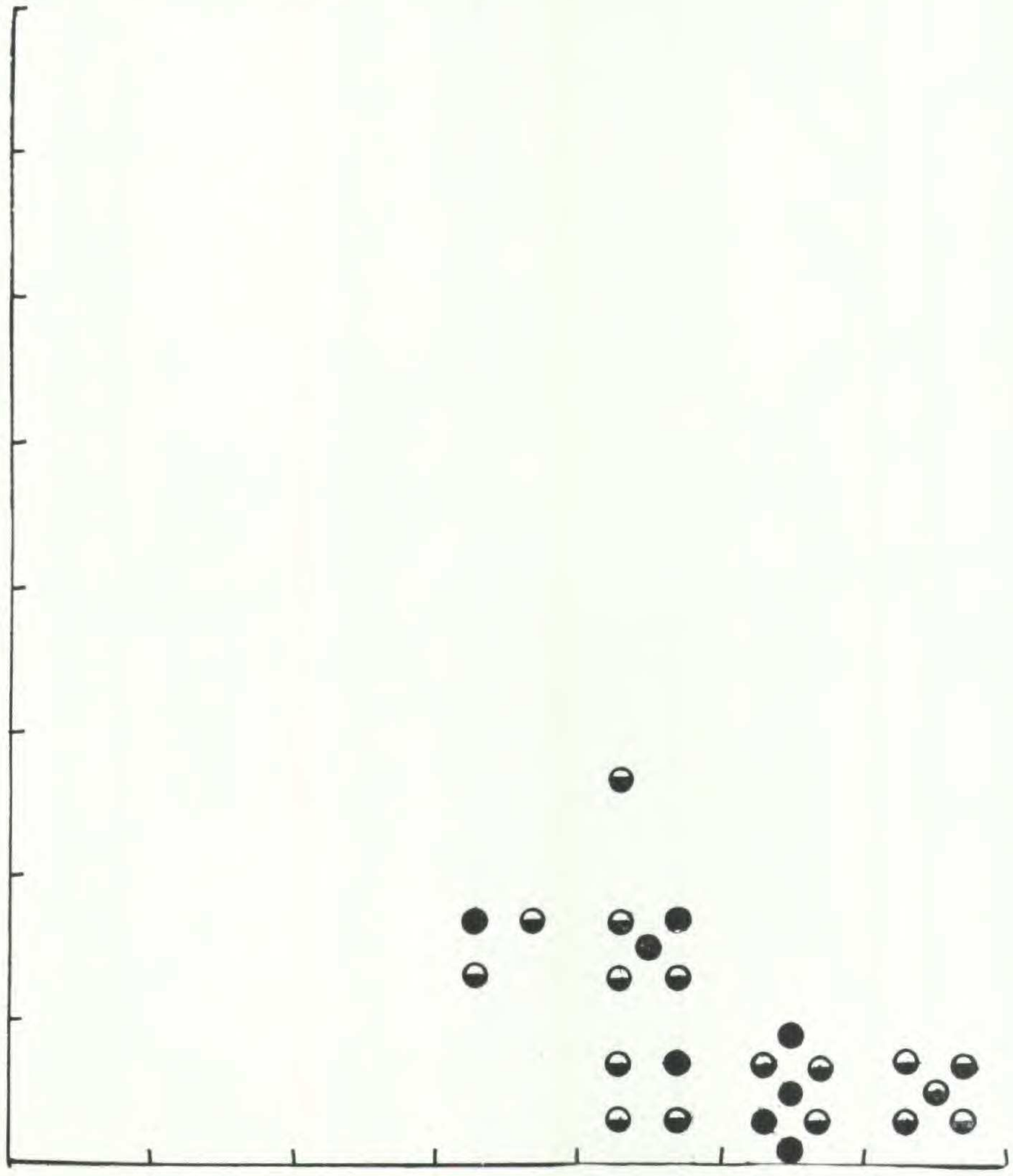
From an old *hacienda* a few miles down the river from Tuxcacuesco. The corn was prevailingly white though most of the ears had at least a few yellow kernels. Four of the ears had kernels with colored aleurone (mostly *Pr*, one *pr*). Four of the ears had faint pericarp color (P^{cr}). The name means "from Colima," which is not far distant. Note change in position of the scale.



7. San Gabriel, Jalisco. *Maíz blanco*

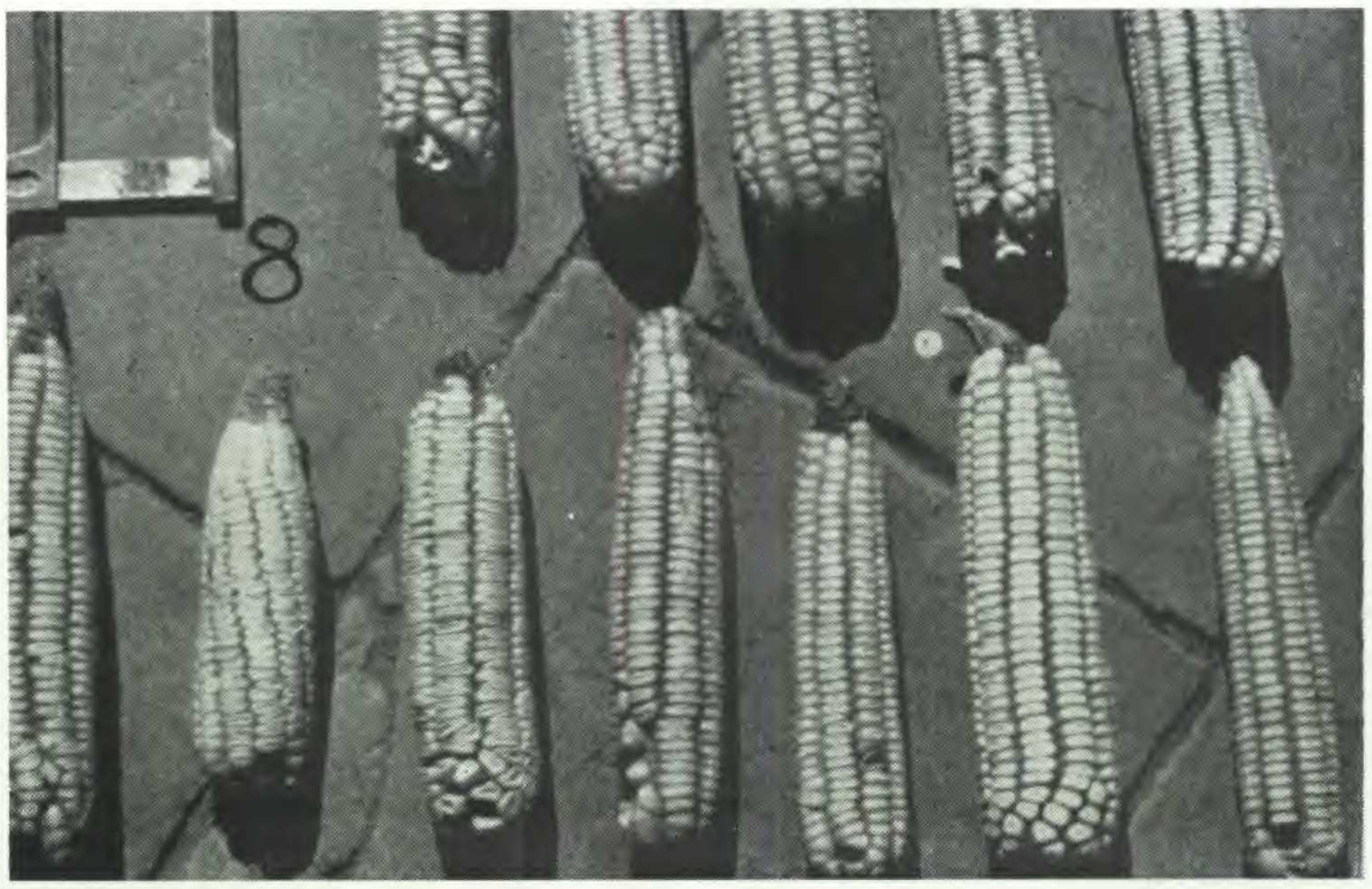
Two of the ears showed a tan pericarp; one had mosaic pericarp *(P^mo)*. The corn was prevailingly white, a few ears showed yellow kernels. Scale shifted to left because of very wide kernels.

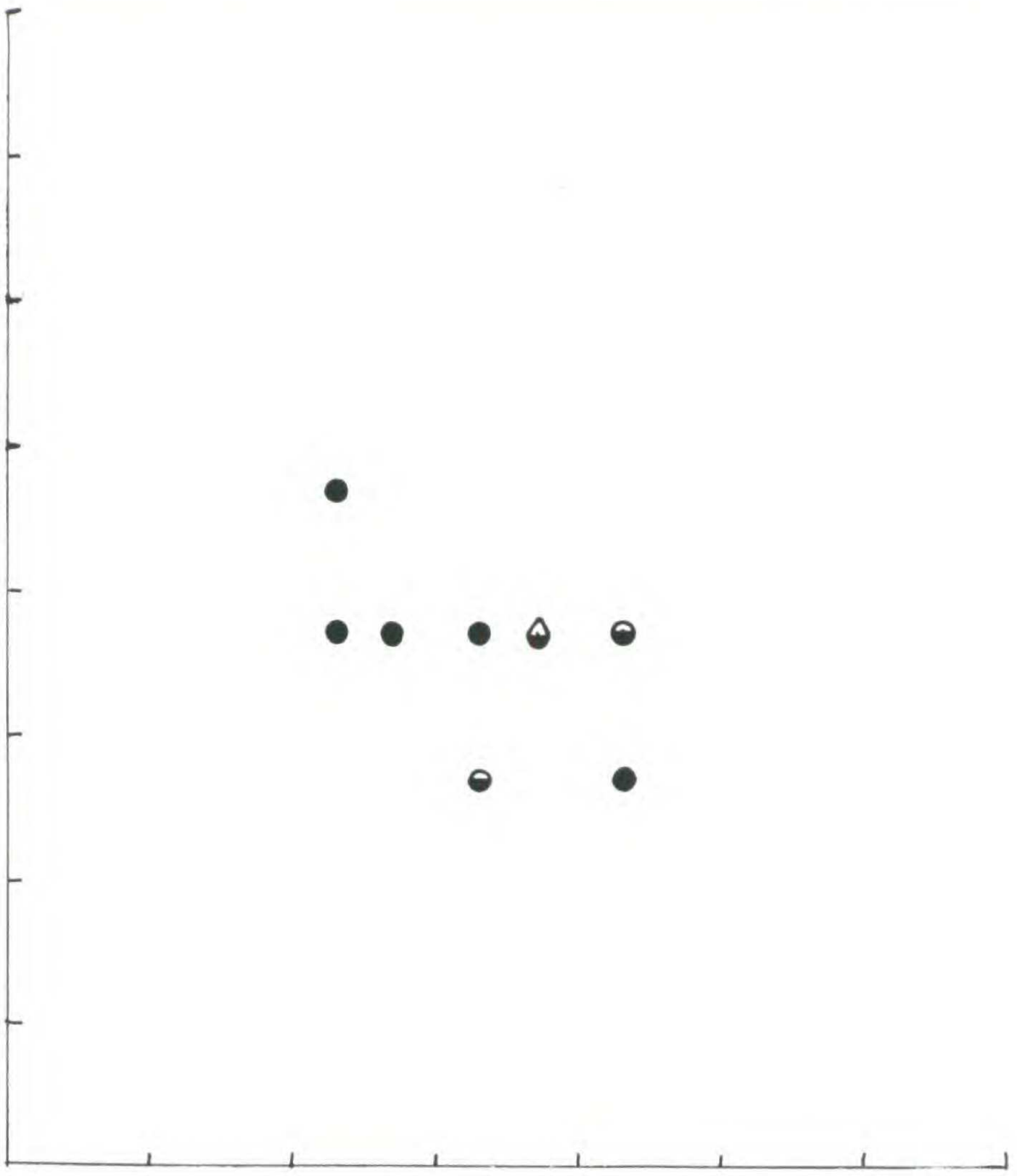




8. Tuxcacuesco, Jalisco. *Maíz blanco*

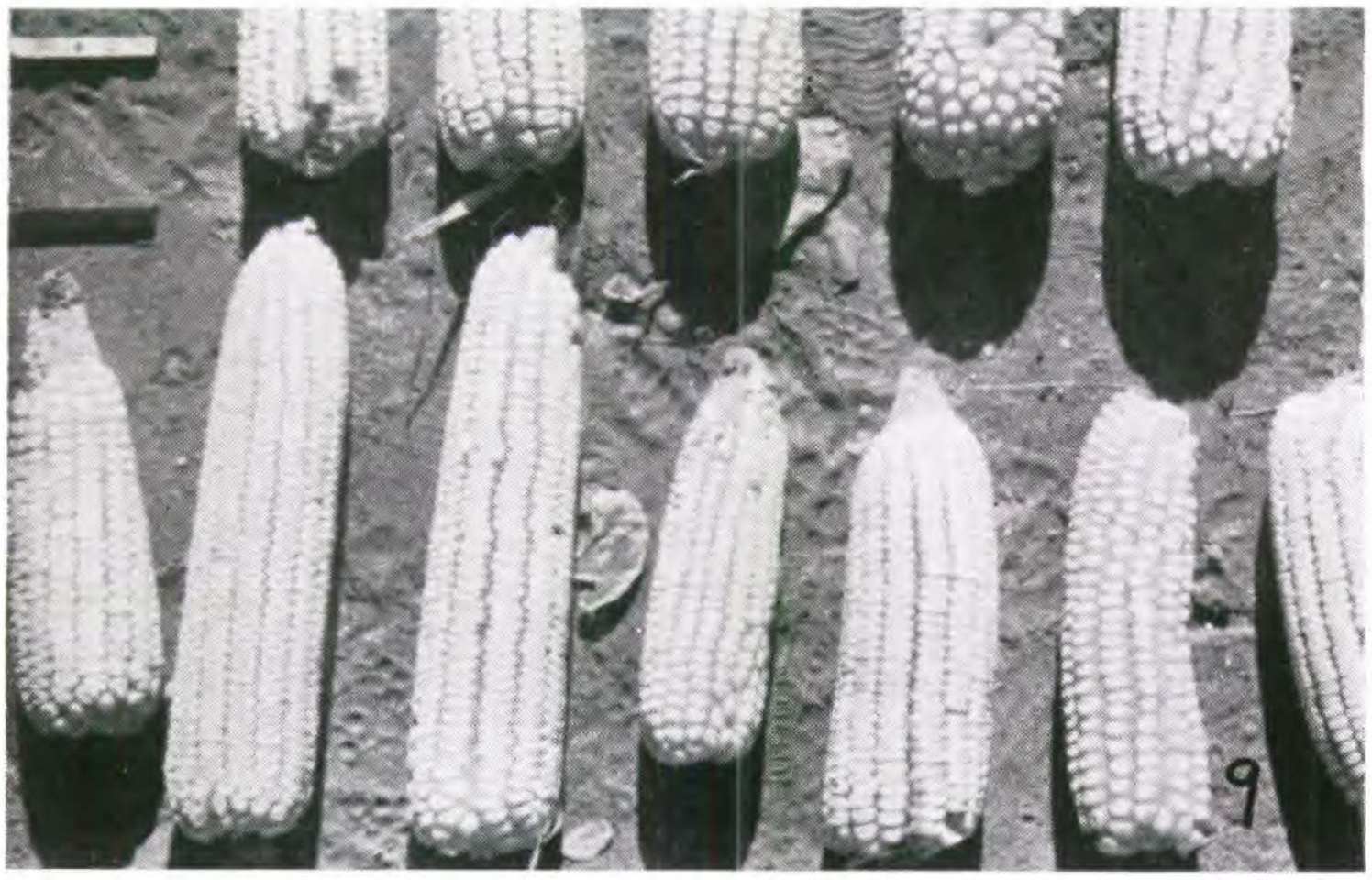
The kernels of this variety were all heavily and conspicuously capped with soft white starch. Prevailingly white, a few ears with occasional yellow kernels and a very few with colored aleurone *(Pr* and *pr)*.

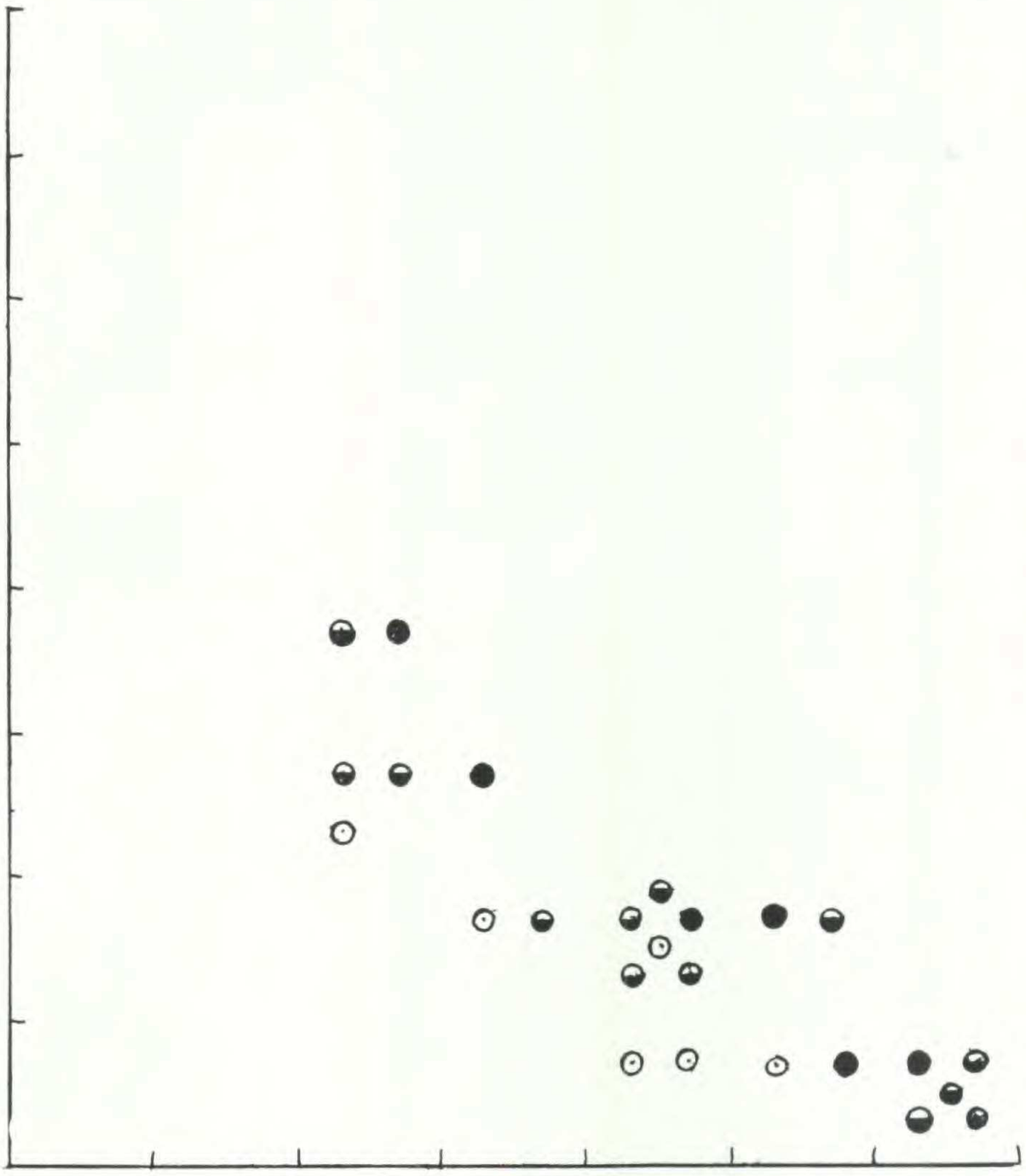




9. Palmar, Jalisco

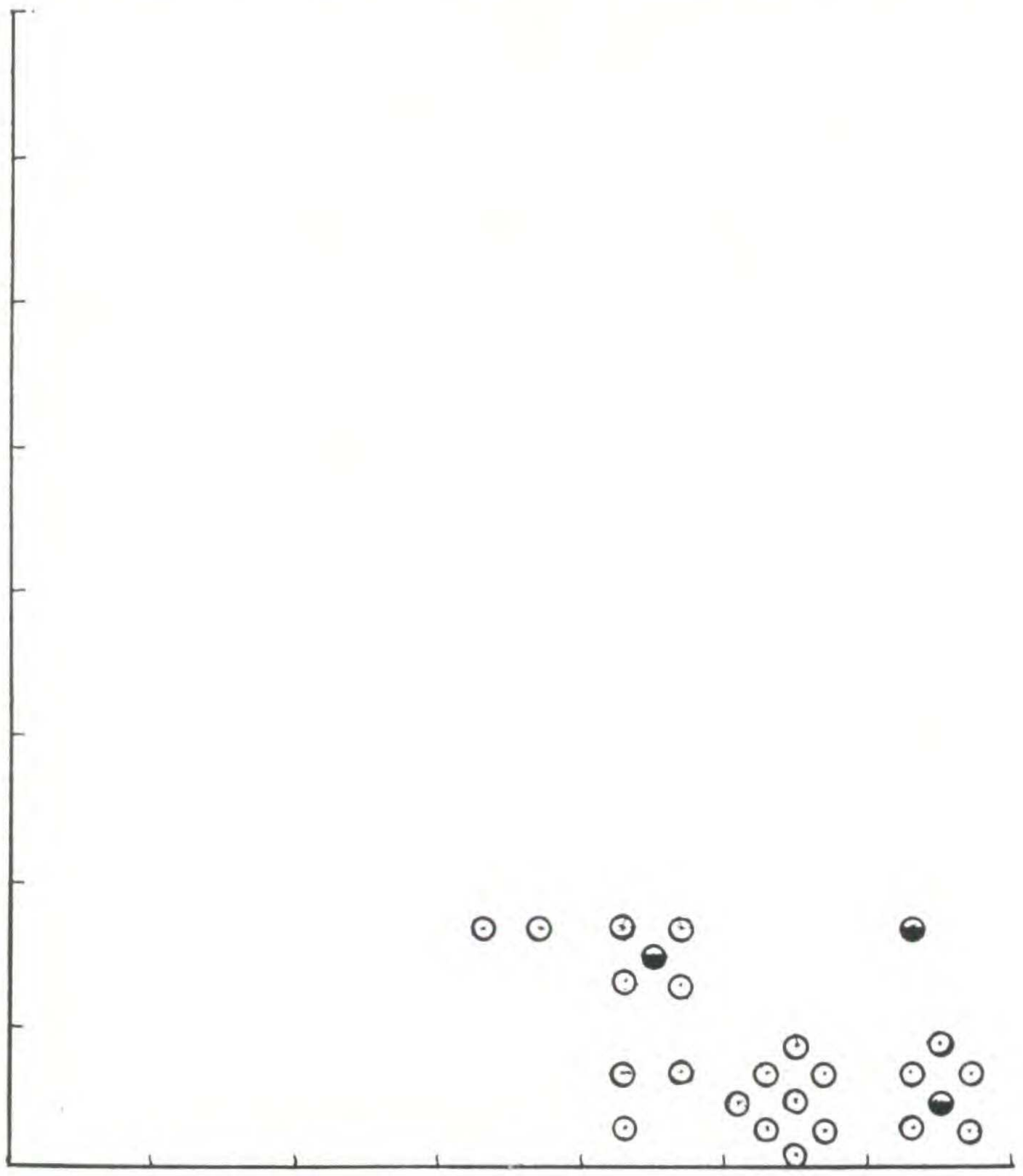
From clearings in the mountains a few miles west of Tuxcacuesco. Prevailingly white with many yellow kernels and some yellow ears.





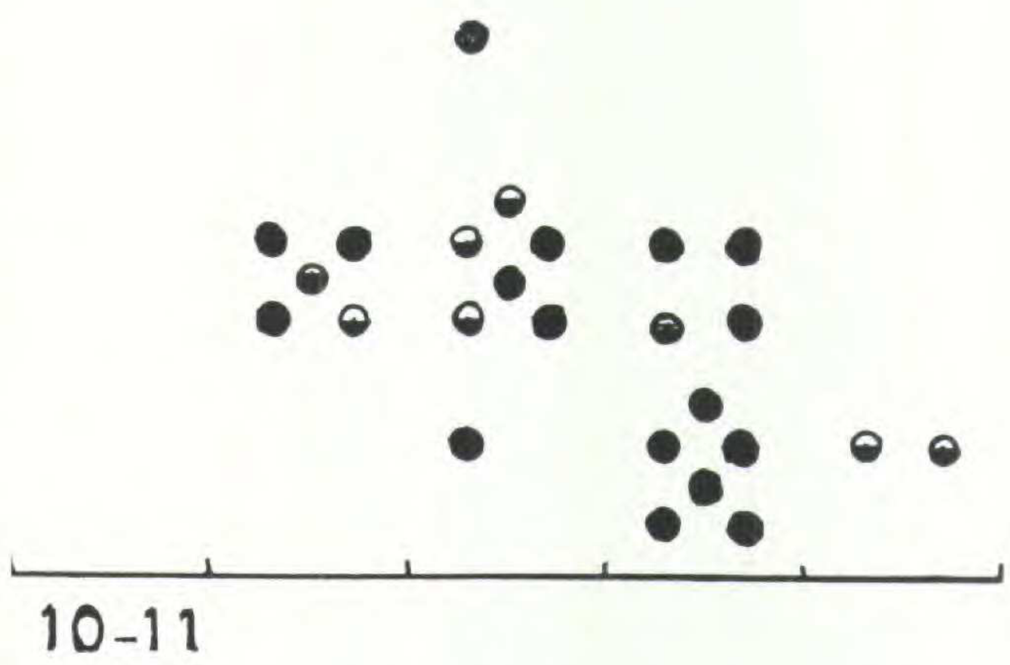
10. Ameca, Jalisco. *Maíz amarillo*

Bought in the sack by the family who let me measure it. Probably came from some of the mountains near by. Shows a strong infusion of Mountain Yellow. Prevailingly yellow. Eight of the ears had tan pericarp, one a pale pink pericarp. Most of the ears were segregating for bright versus pale yellow.



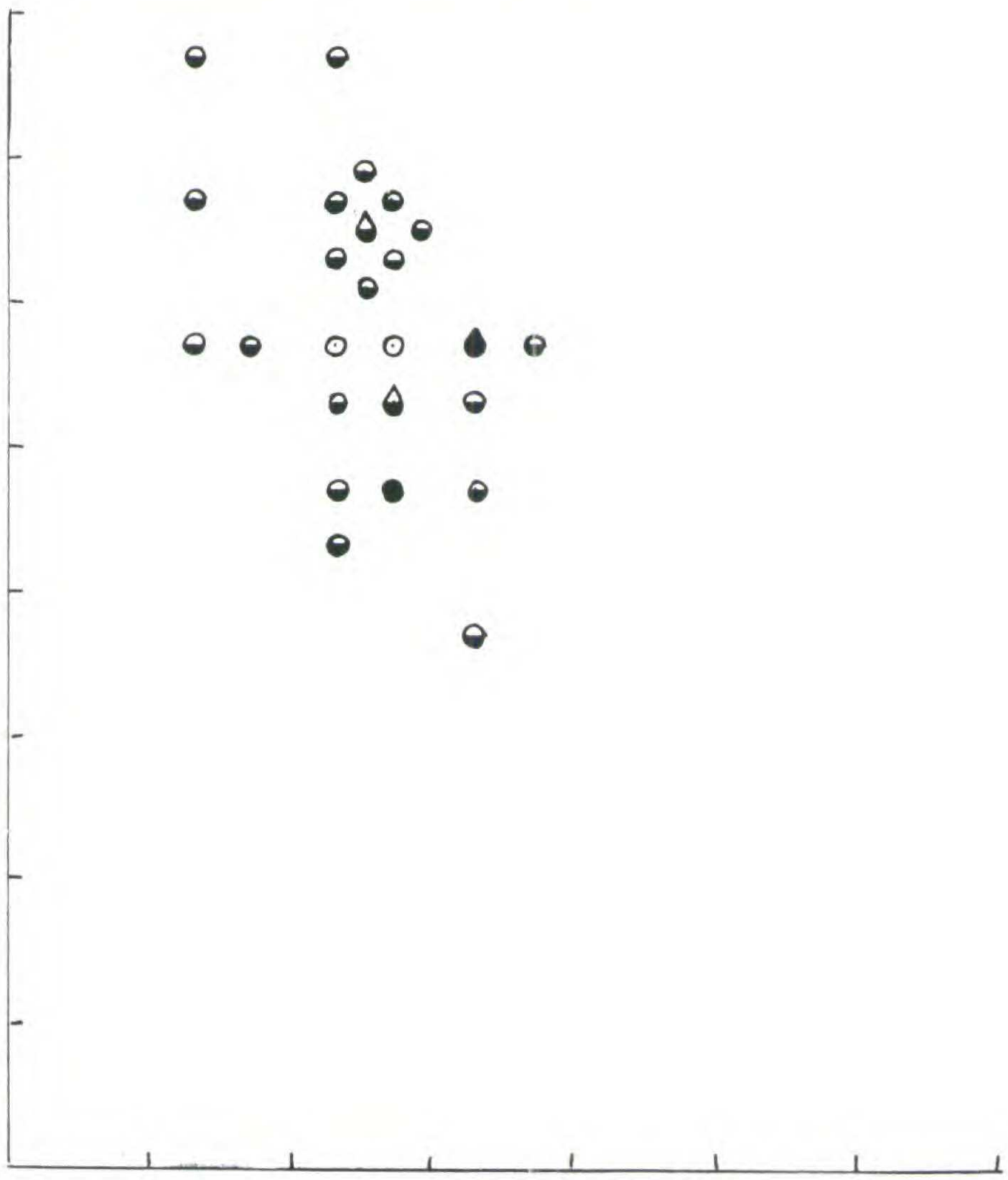
11. Ameca, Jalisco. *Maíz liso*

A smooth, glistening flint, as the name implies. Said to be very common in the region between Ameca and the coast. Two examples were found in a casual survey of corn being stored or sold in the central part of the city. Said to be used sometimes as a popcorn. Prevailingly white with a few yellow kernels on nearly every ear.



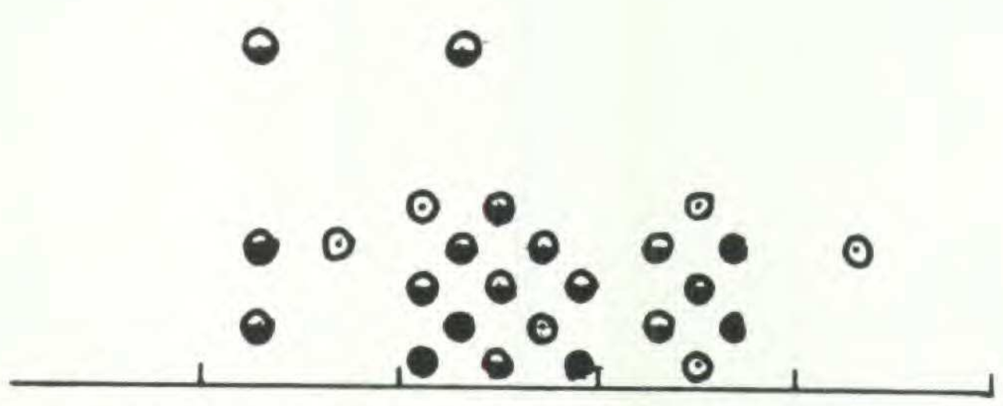
12. Ameca, Jalisco. *Maíz areneño*

This variety is so wide-kernelled that the scale has had to be shifted as noted in the diagram. Yellow and white, heavily capped with soft starch and uniformly dented with a smooth, even dent. A few kernels with colored aleurone *(Pr)*.



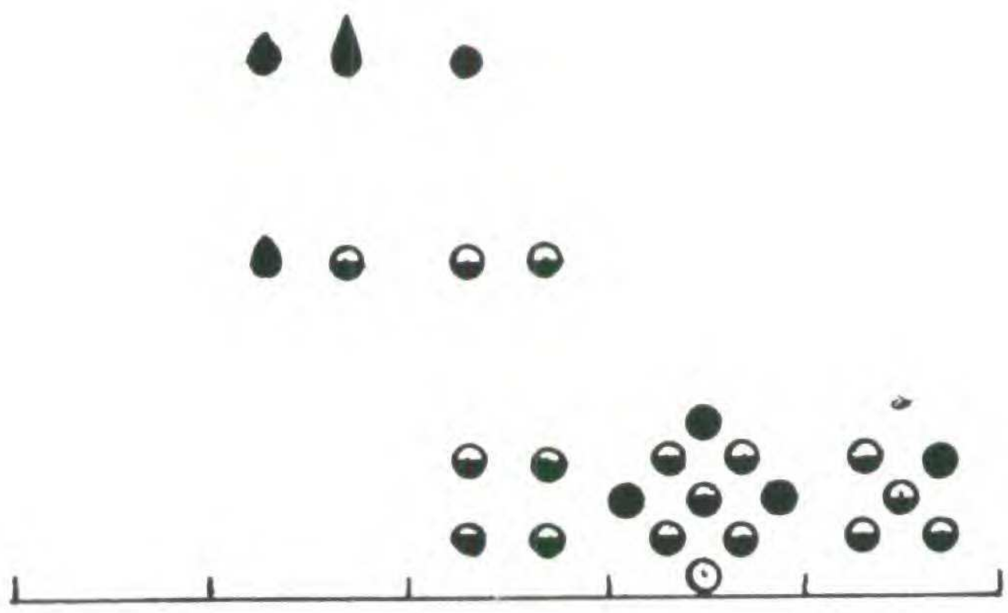
13. Tlajomulco, Jalisco. *Maíz dulce* (See plate 8)

This variety has been the subject of a special monograph by Kelly and Anderson. It had been grown in a garden with a red aleurone "elote" variety, apparently for more than one season since one ear was segregating. All the contaminated kernels were *pr* rather than *Pr*. *Maíz dulce* is homozygous for sweet endosperm, but a few of the ears showed partial suppression of the sweet and these ears all had high row numbers (20 or above) and were evenly tapered like Mexican Pyramidal. The denting was scored on the contaminated kernels. The *pr* kernels were usually spotted rather than evenly flushed with color. All the ears had yellow endosperm with varying amounts of dull red in the pericarp (various alleles of P^{cr}).



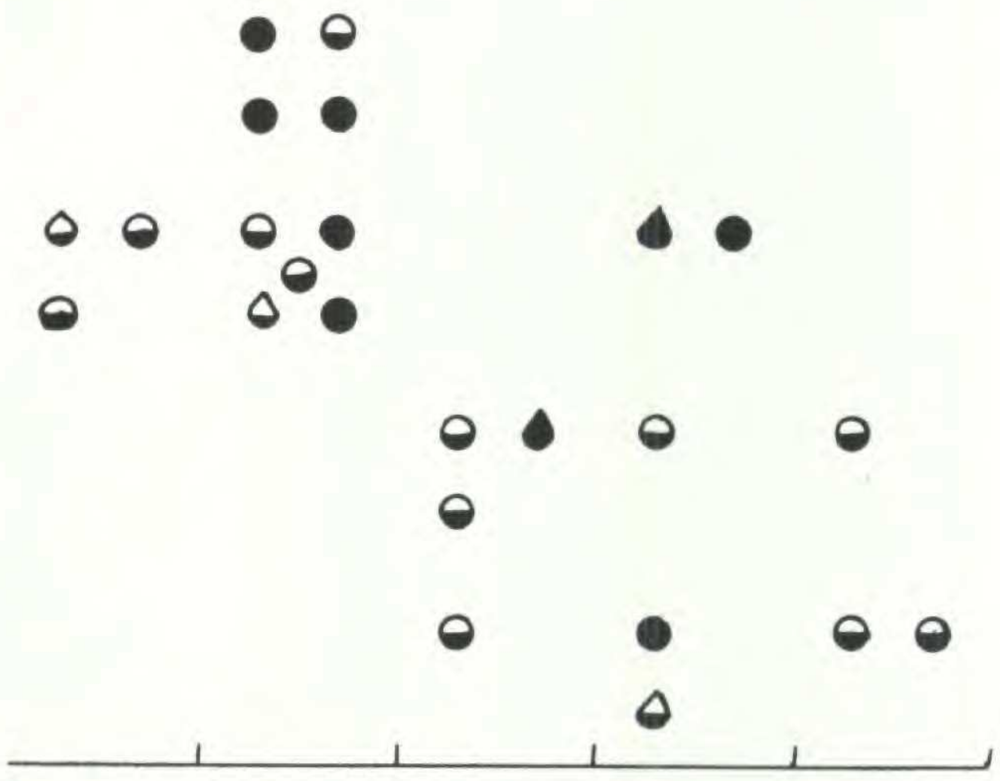
14. Tlajomulco, Jalisco. *Maíz criollo*

Tlajomulco is an ancient town of great importance in colonial times but now isolated from the railroad and the highway. Samples of maize from it are less likely to show the influence of modern varieties. Note that the extremely wide kernels have made it necessary to change thé scale as indicated in the diagram. This variety was prevailingly white, most of the ears showing a few yellow kernels. Two of the ears showed colored aleurone on one or two kernels *(pr)*. One ear showed a brilliant red flush (probably some allele of *R*).



15. San Pedro, Tlaquepaque, Jalisco. *Maíz criollo*

From a little pottery-making town a few miles east of Guadalajara. Yellow and white with a few ears showing occasional kernels with colored aleurone. This variety was studied in the field when the plants were still fresh enough to show plant color. They had slight to strong color above the veins on the lower sheaths with slight to no interveinal color. The upper sheaths showed little color. Tassel branches varied from 5 to 24, with an average of 13. The male glumes were 10 to 14 mm., with an average of 12.



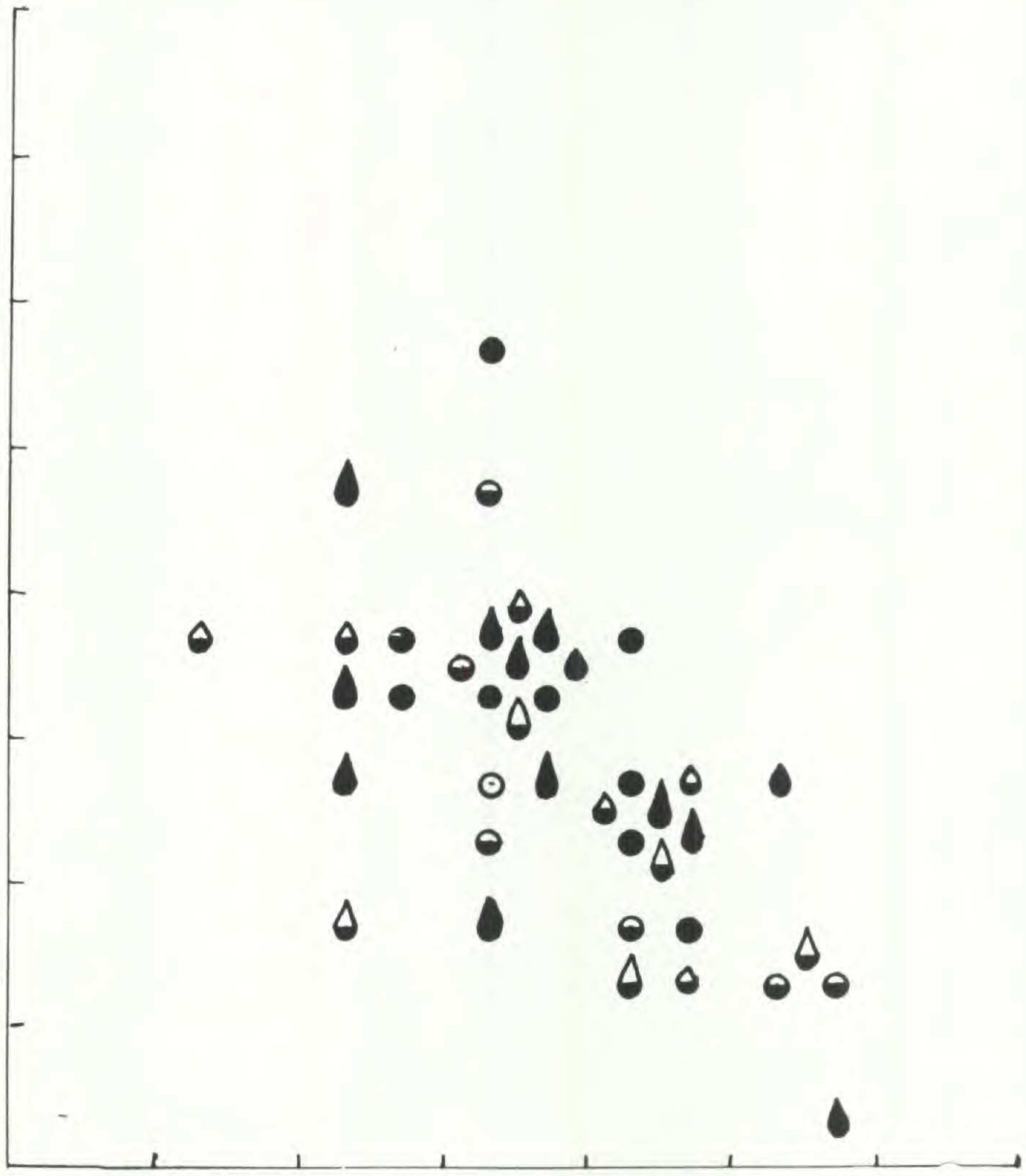
16. S. P. Tlaquepaque, Jalisco. *Maíz ancho*

Grown on a field which was better watered than the rest of the fields in town and therefore had a longer growing season. This and the next diagram are two selections from the same field made at husking time. In this one I accepted all the ears handed me by the workmen to avoid offending them. The second selection is strictly at random. Both selections are prevailingly white, with one all-yellow ear and a few yellow kernels on most of the ears. There was one ear with a crowned red pericarp *(P^{cr})*. The field was outstanding in uniting a high degree of productivity with great variability in type of ear. One extreme ear shown in fig. 8.

10-11

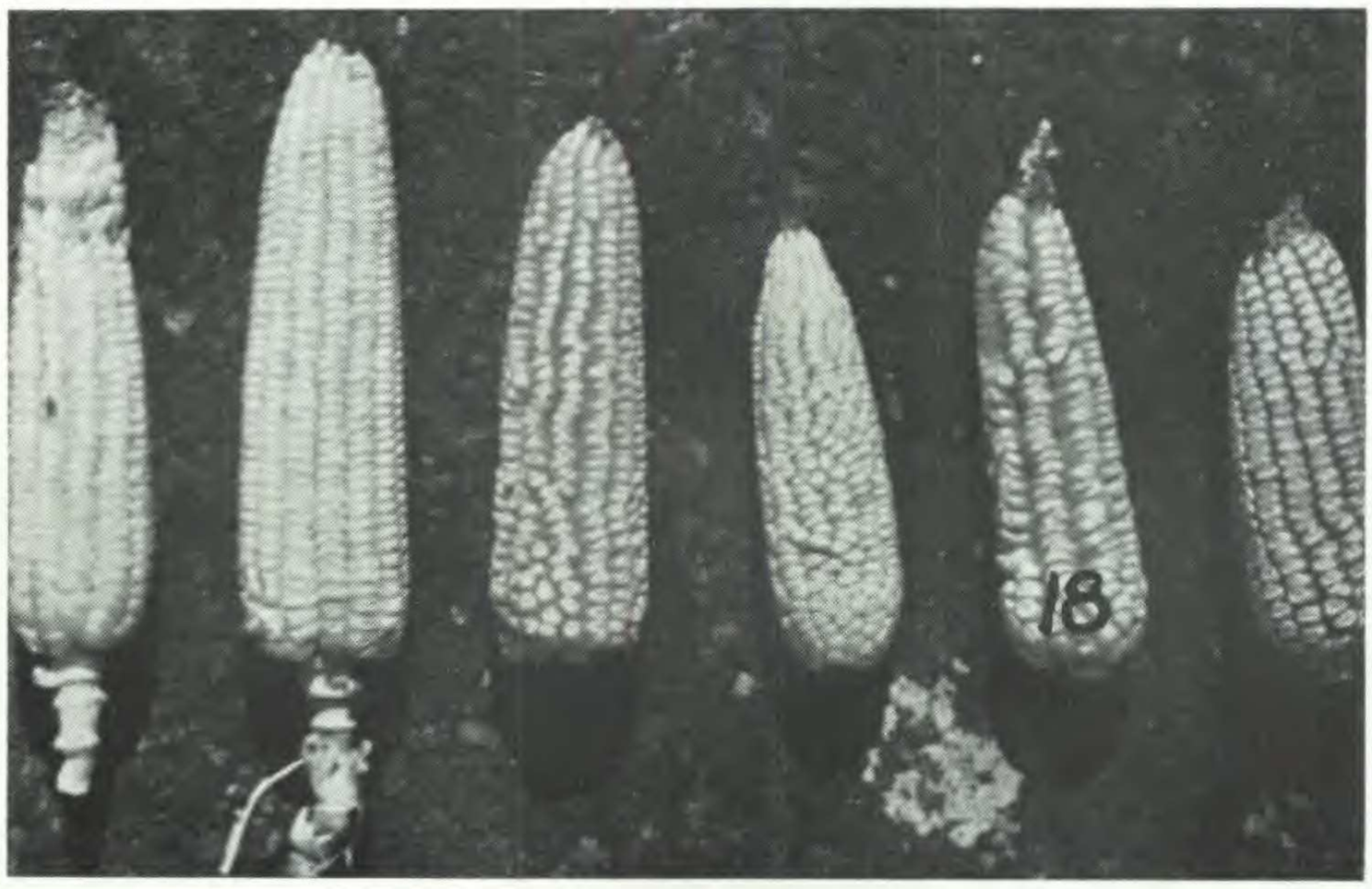
17. S. P. Tlaquepaque, Jalisco. *Maíz ancho*

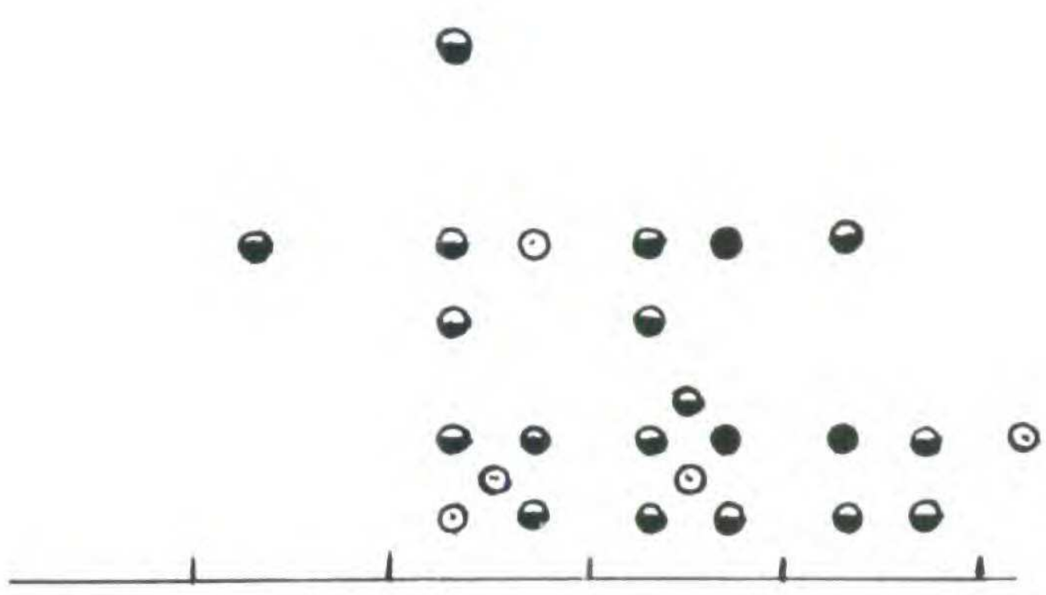
A second sample from the same field; see the previous account. Extremely variable and productive. This photograph is not to the same scale as the others in the Appendix.



18. S. P. Tlaquepaque, Jalisco. *Maíz chino*

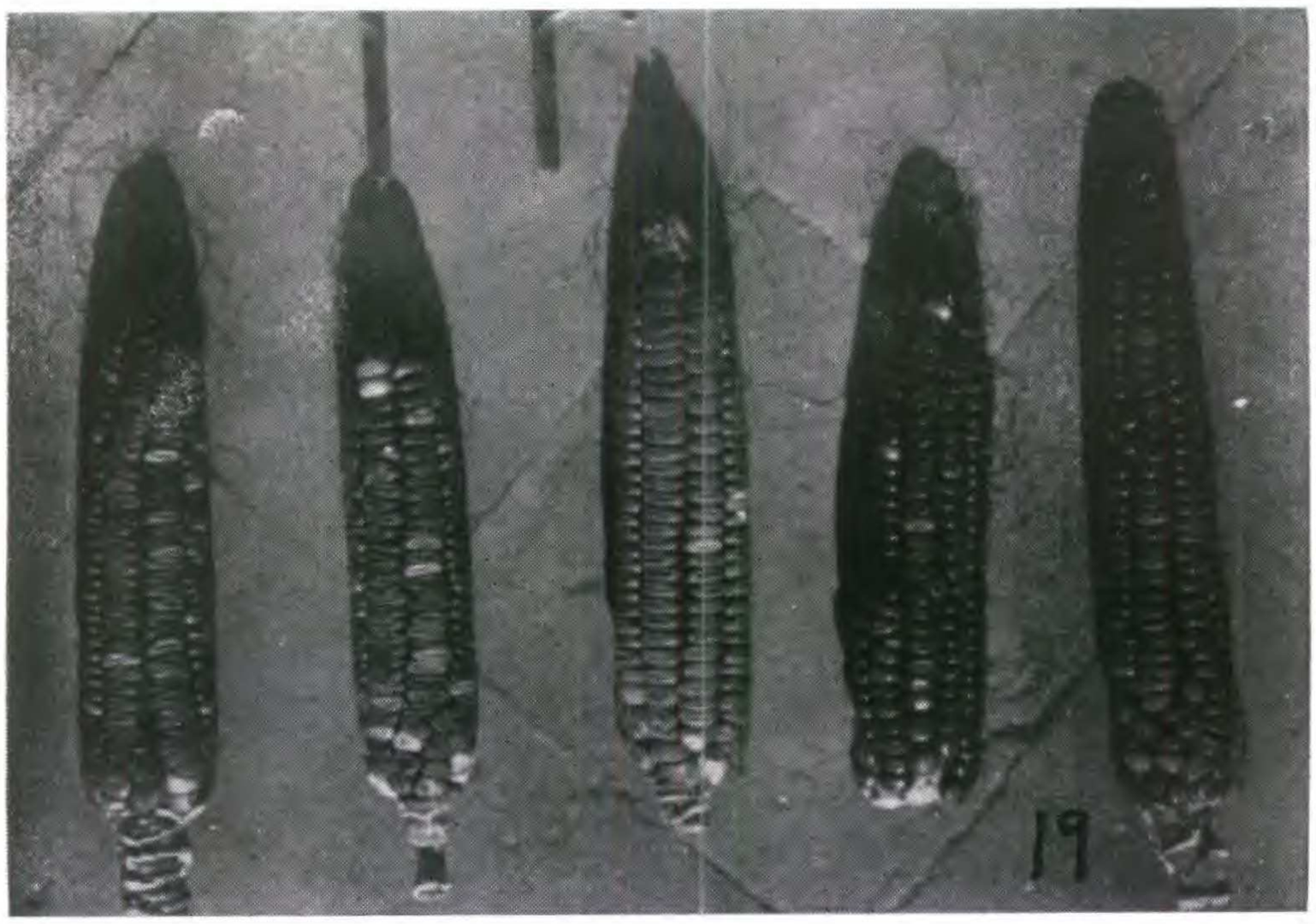
Prevailingly white. *Maíz colorado (pr)* was planted at the end of the field. Cross pollinations indicate this variety is mostly *Pr*, C^i. Sample of 40 ears.

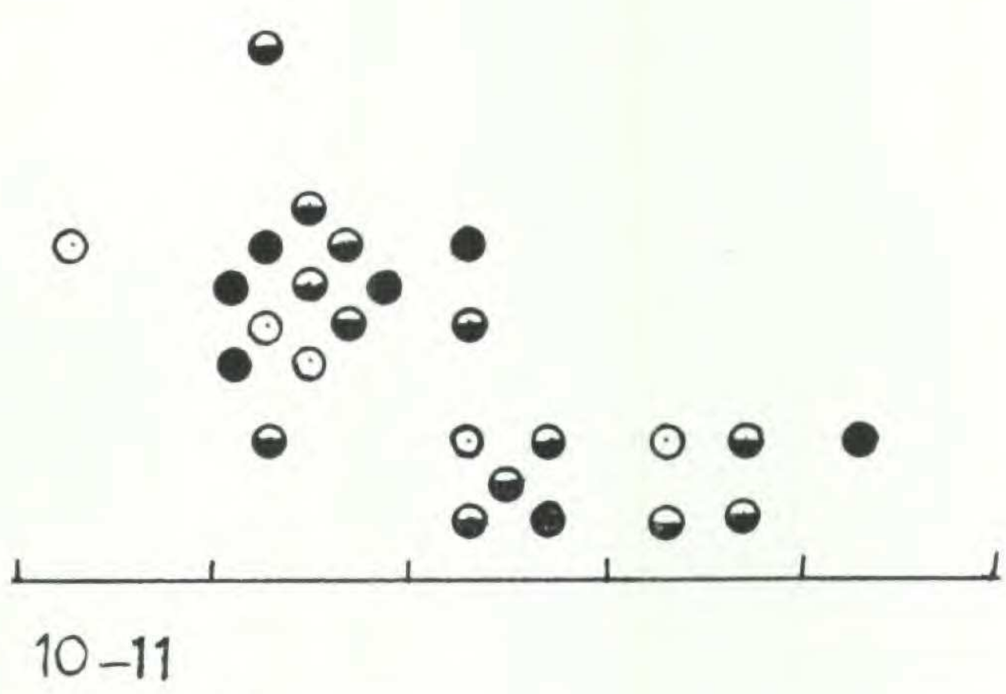




19. S. P. Tlaquepaque, Jalisco. *Maíz colorado y maíz negro*

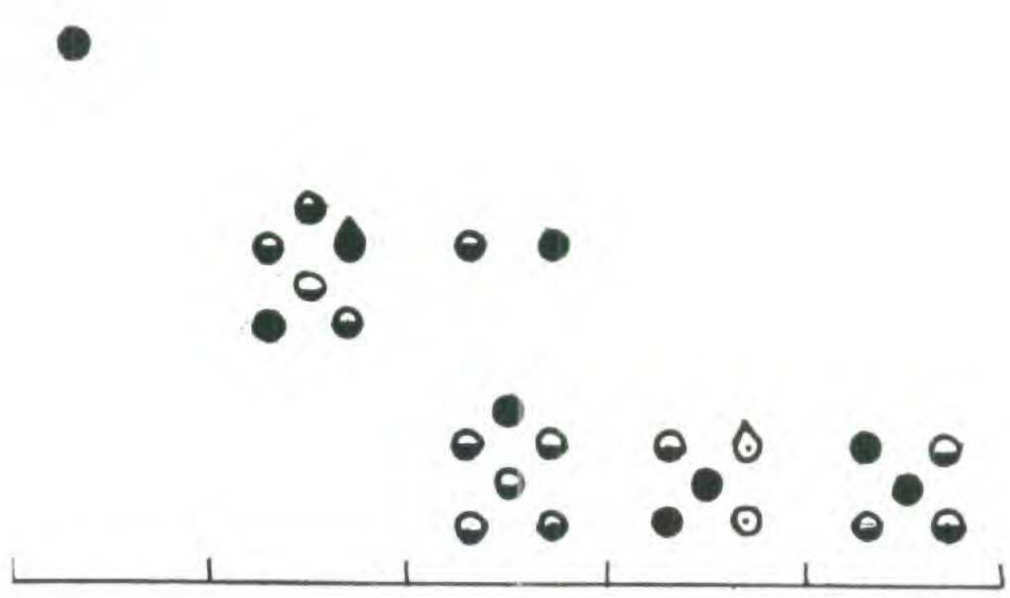
A badly mixed field of "elote" corn grown by a poor widow. Note that the scale has been changed because of the wide kernels.





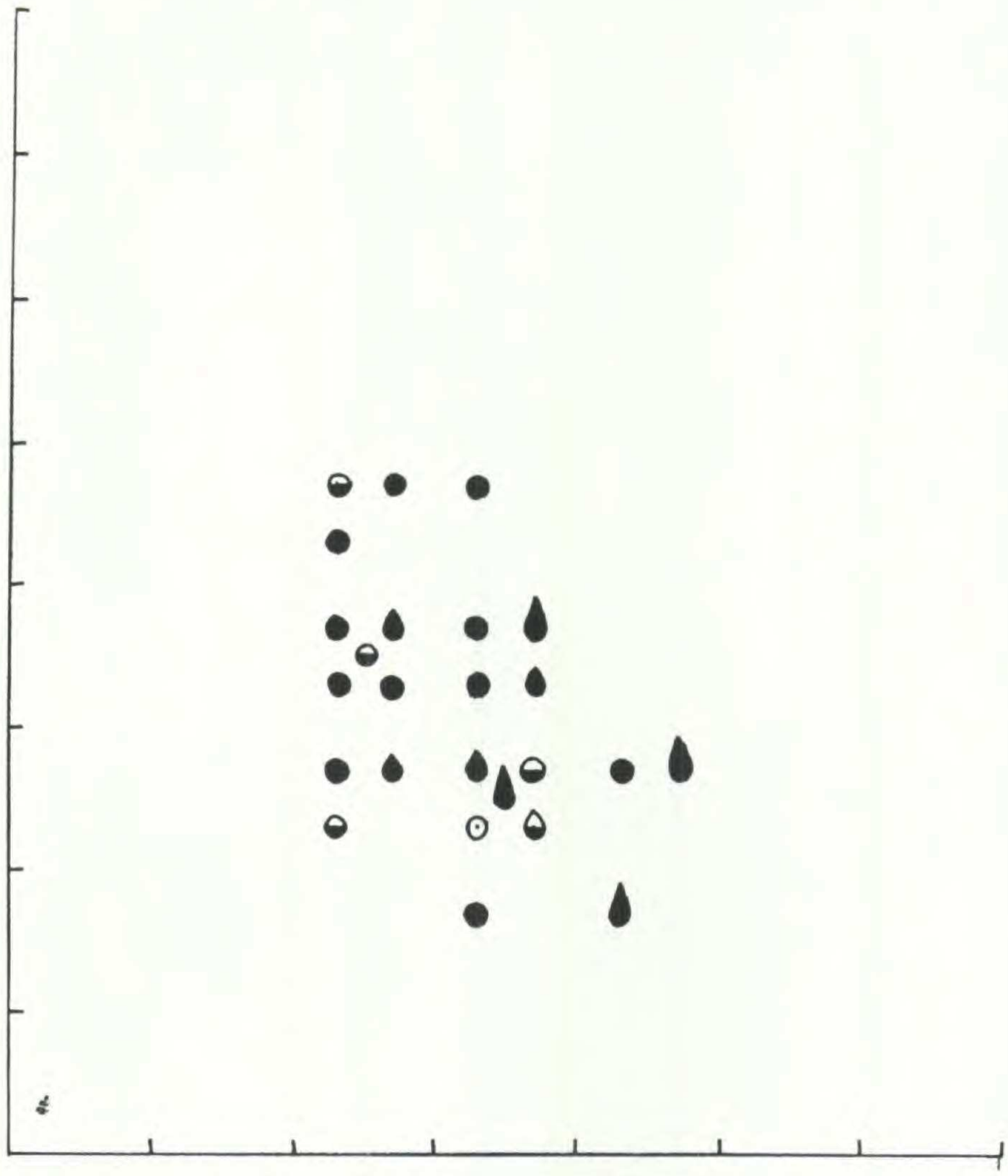
20. S. P. Tlaquepaque, Jalisco. *Maíz criollo*

Prevailingly white. Half of the ears showed a few yellow kernels. Two of the ears had faintly colored aleurone *(pr)*. One ear had faint pericarp color *(P^{cr})*.



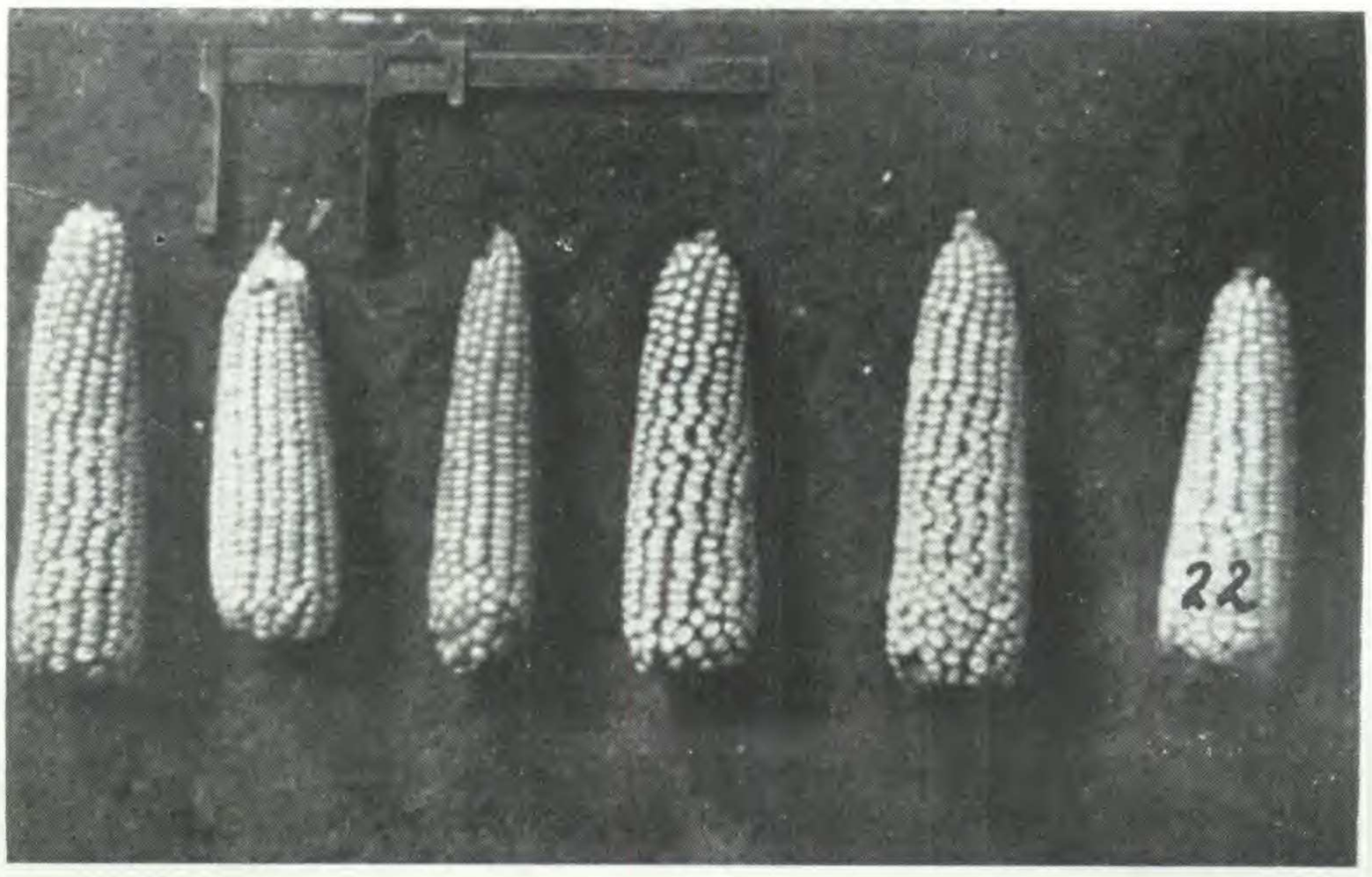
21. Tonolá, Jalisco. *Maíz criollo*

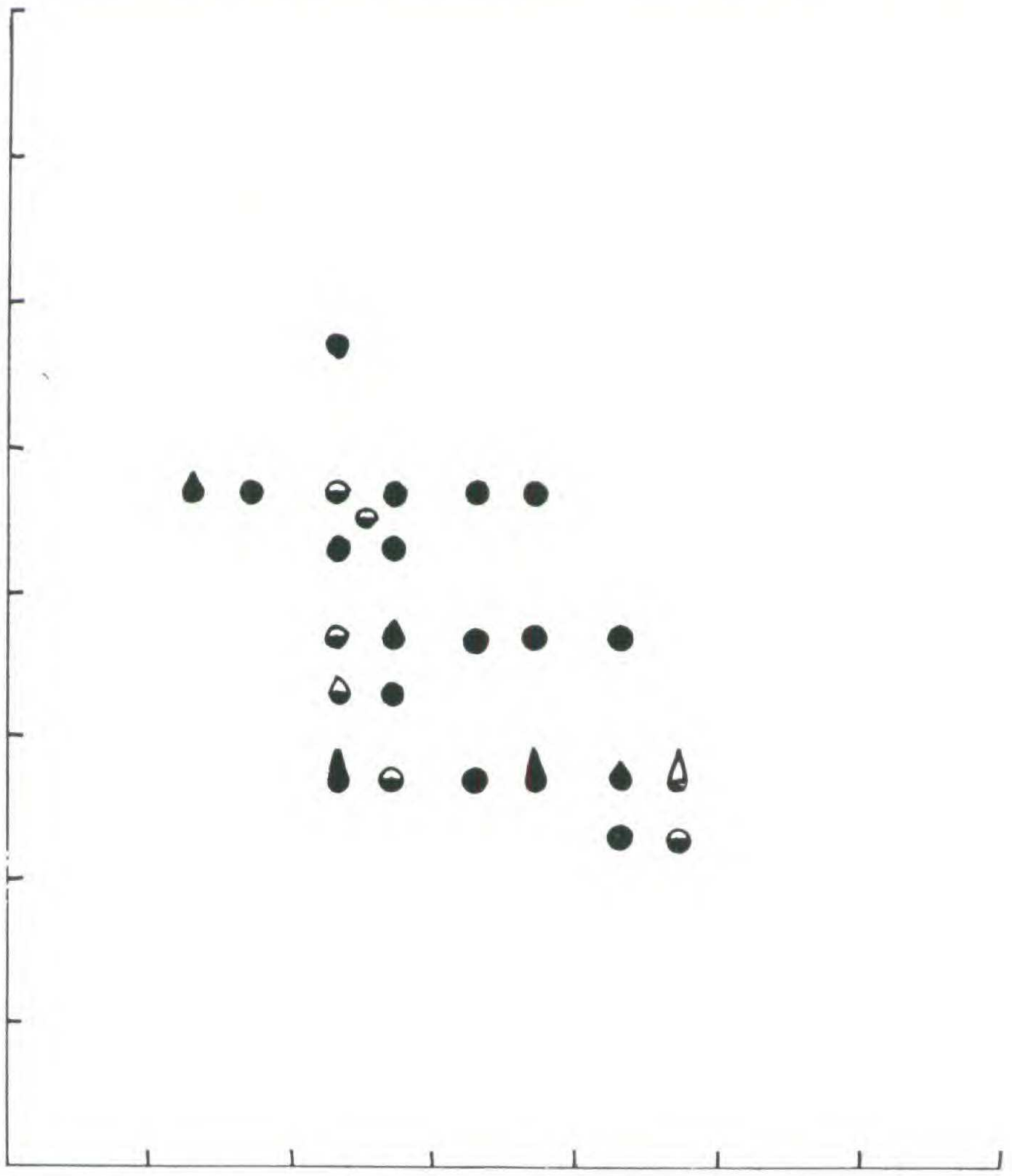
Tonolá is a still more remote pottery town near Guadalajara. Prevailingly white with few to many yellow kernels. A few *Pr* kernels.



22. Tepatitlán, Jalisco. *Maíz valenciana*

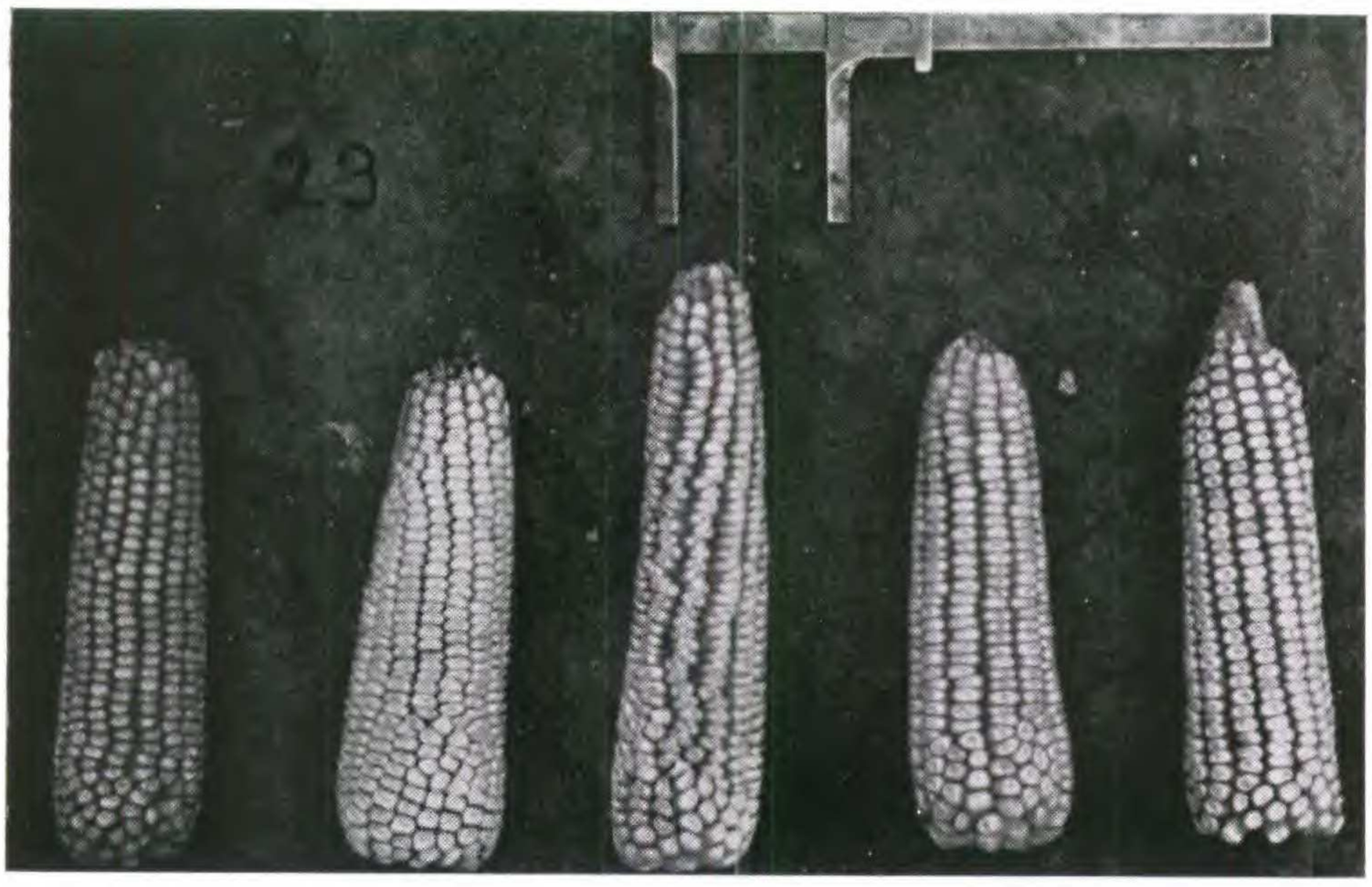
On sale in the local market. Prevailingly yellow, many white kernels and a few colored aleurone *(Pr)*.

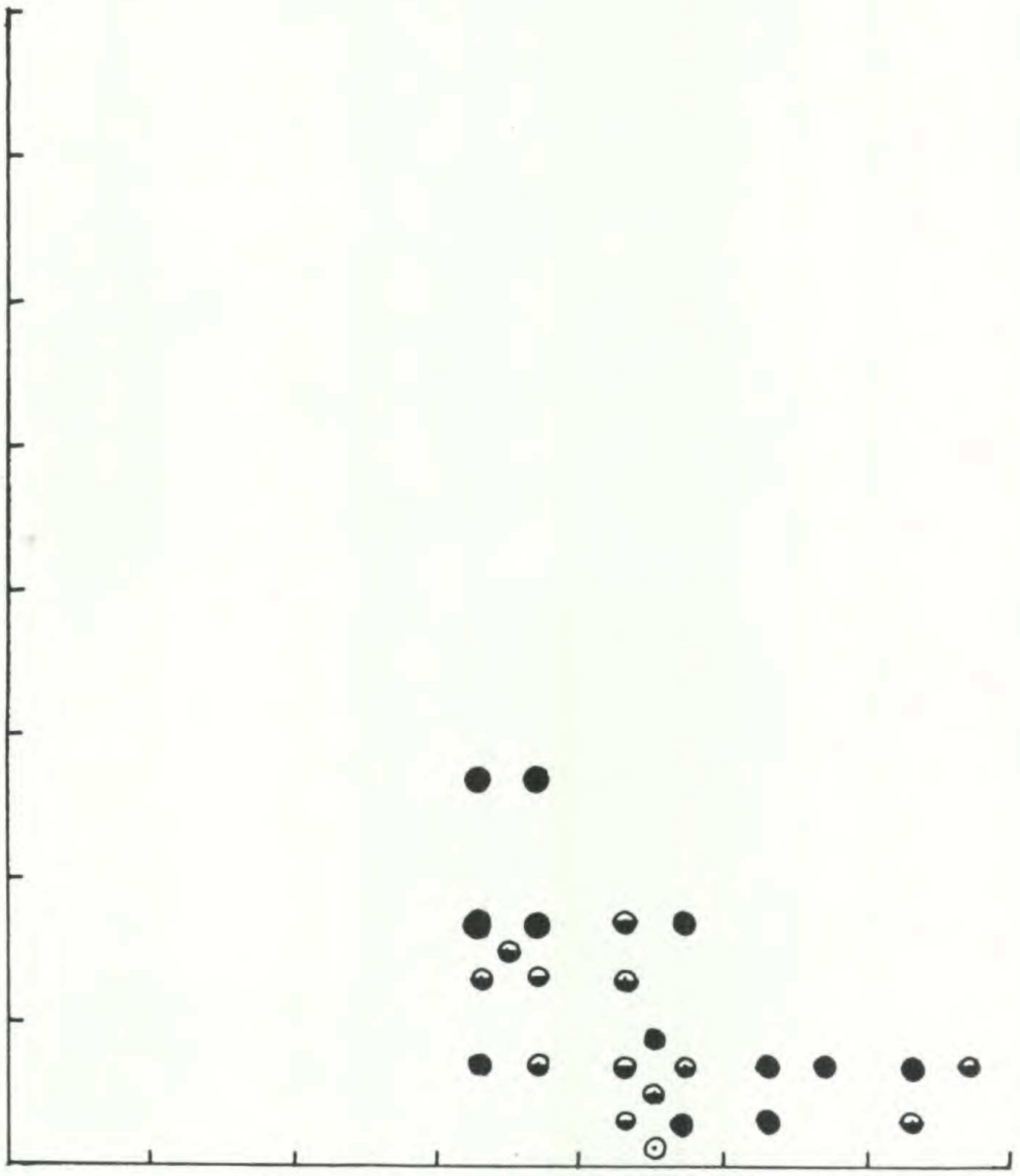




23. Tepatitlán, Jalisco. *Maíz amarillo*

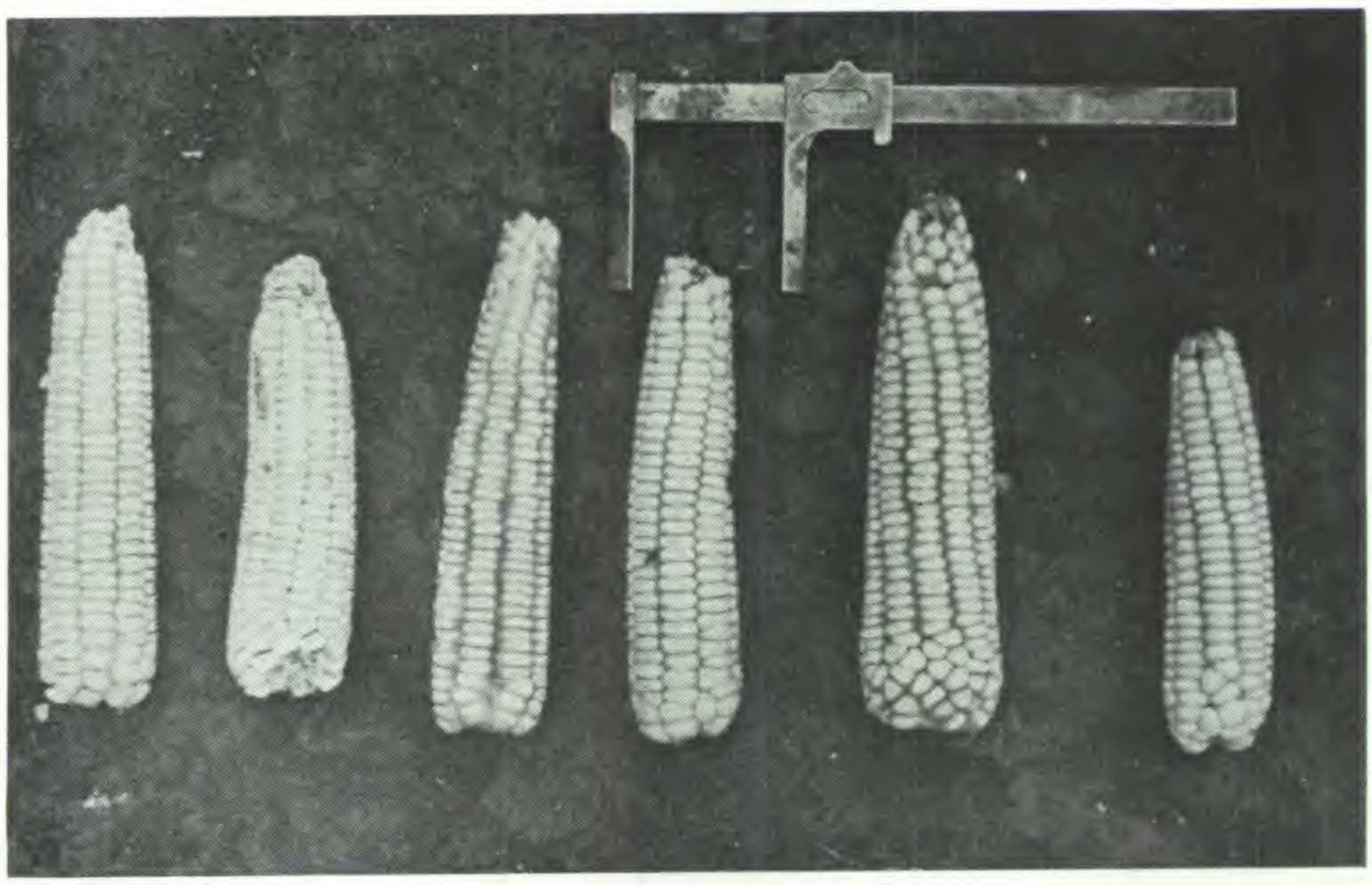
Prevailingly yellow. A minority of the ears with white kernels. Four ears had kernels with colored aleurone *(Pr)*, two ears P^{cr}.

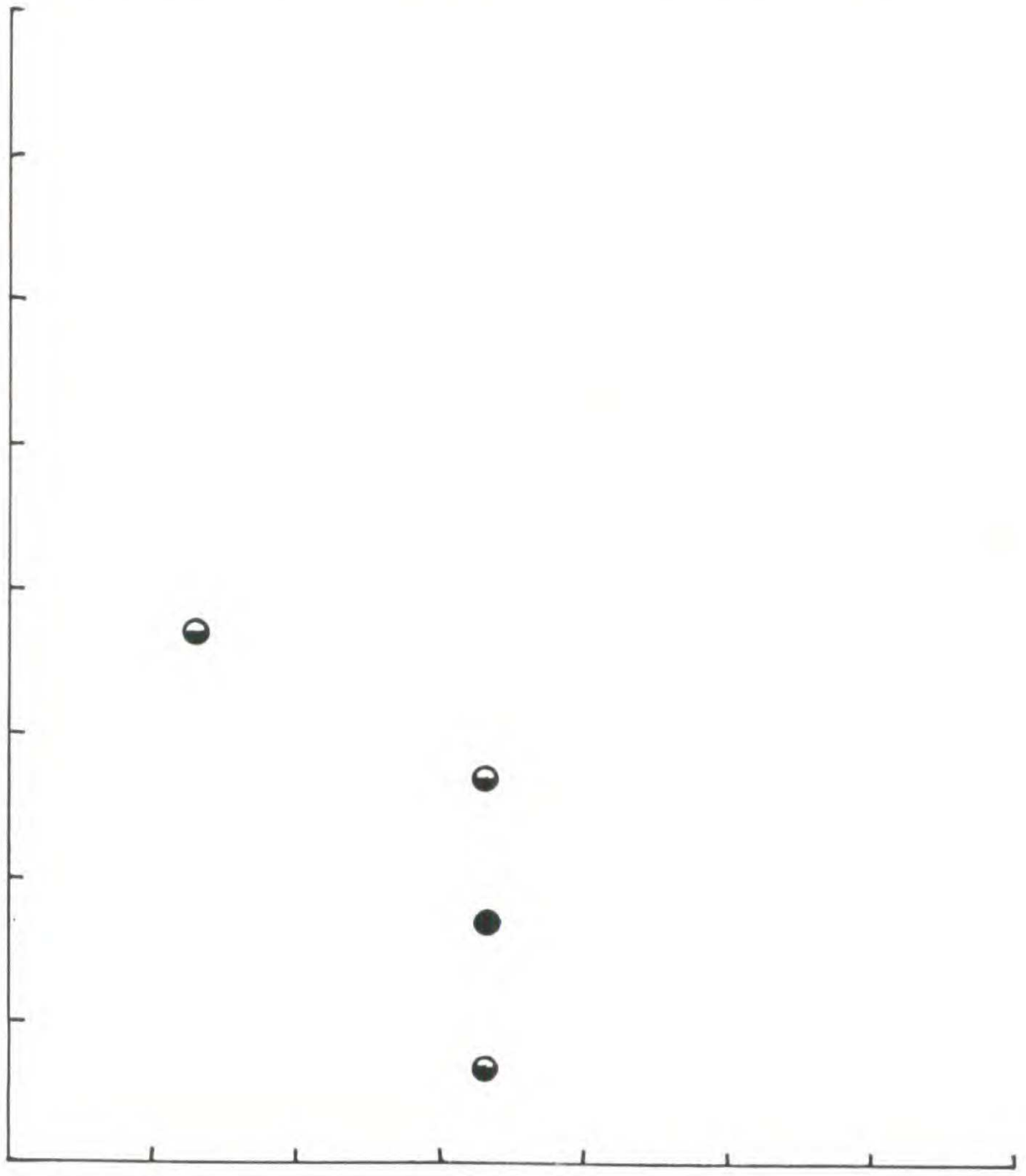




24. Tepatitlán, Jalisco. *Maíz blanco*

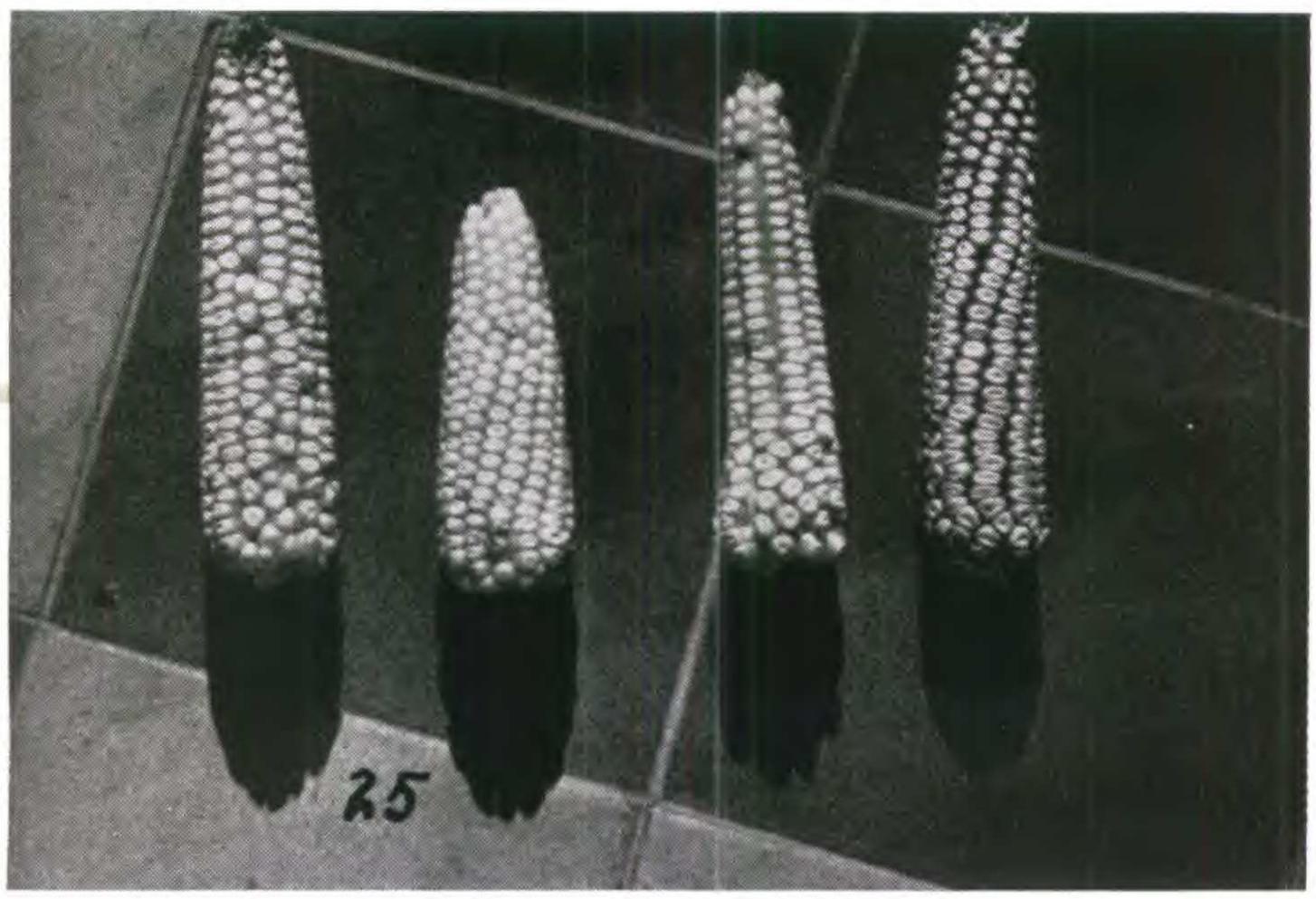
From the same small farm as the preceding variety. Prevailingly white, a minority of the ears with yellow kernels. Grown in an adjoining field to the preceding.

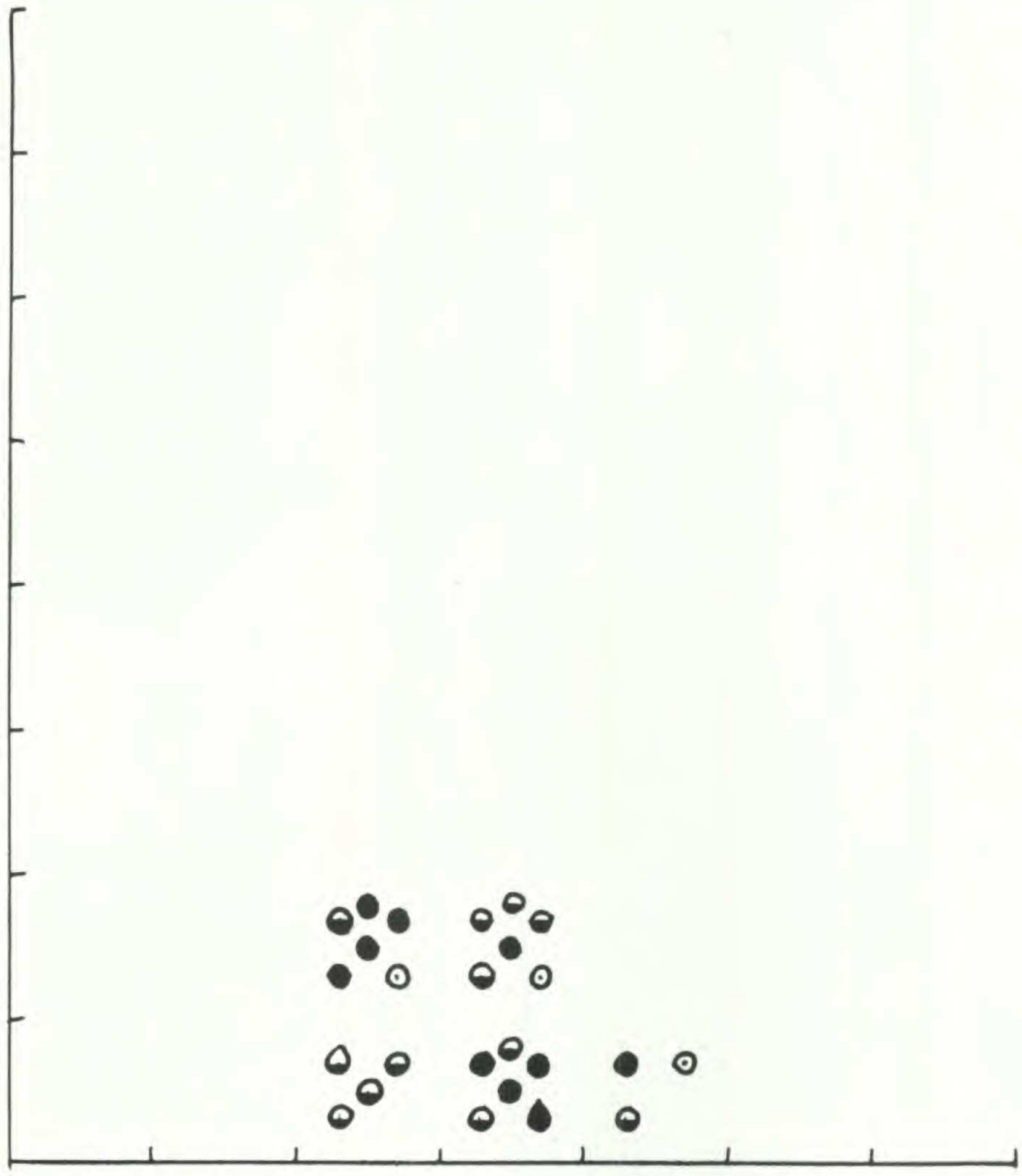




25. Apango, Jalisco. *Maíz amarillo*

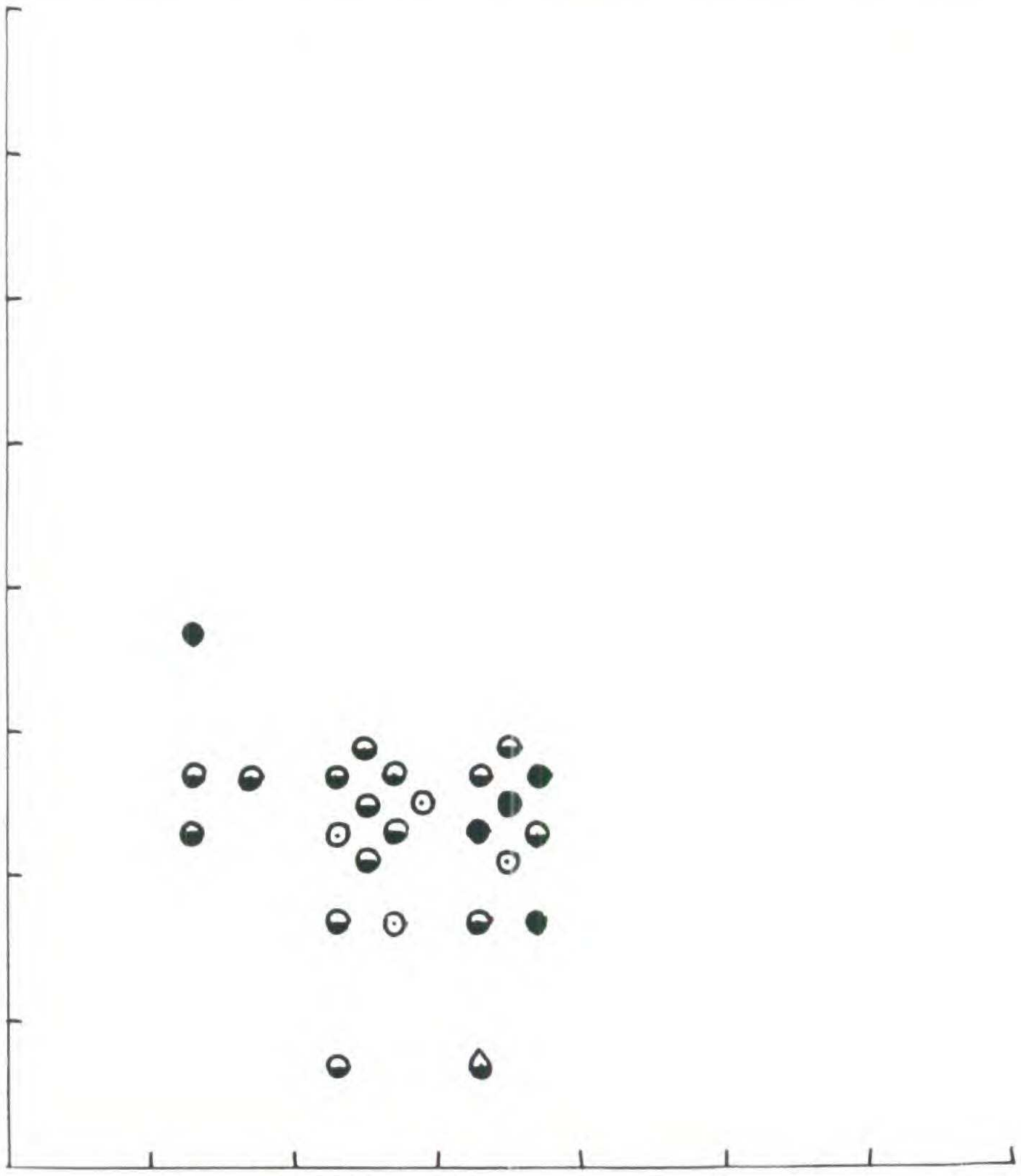
Apango is a tiny town on the north flank of the Volcán de Colima. The ears were selected from a field and represent the extremes. Yellow; one ear strongly colored crown pericarp (P^{cr}).





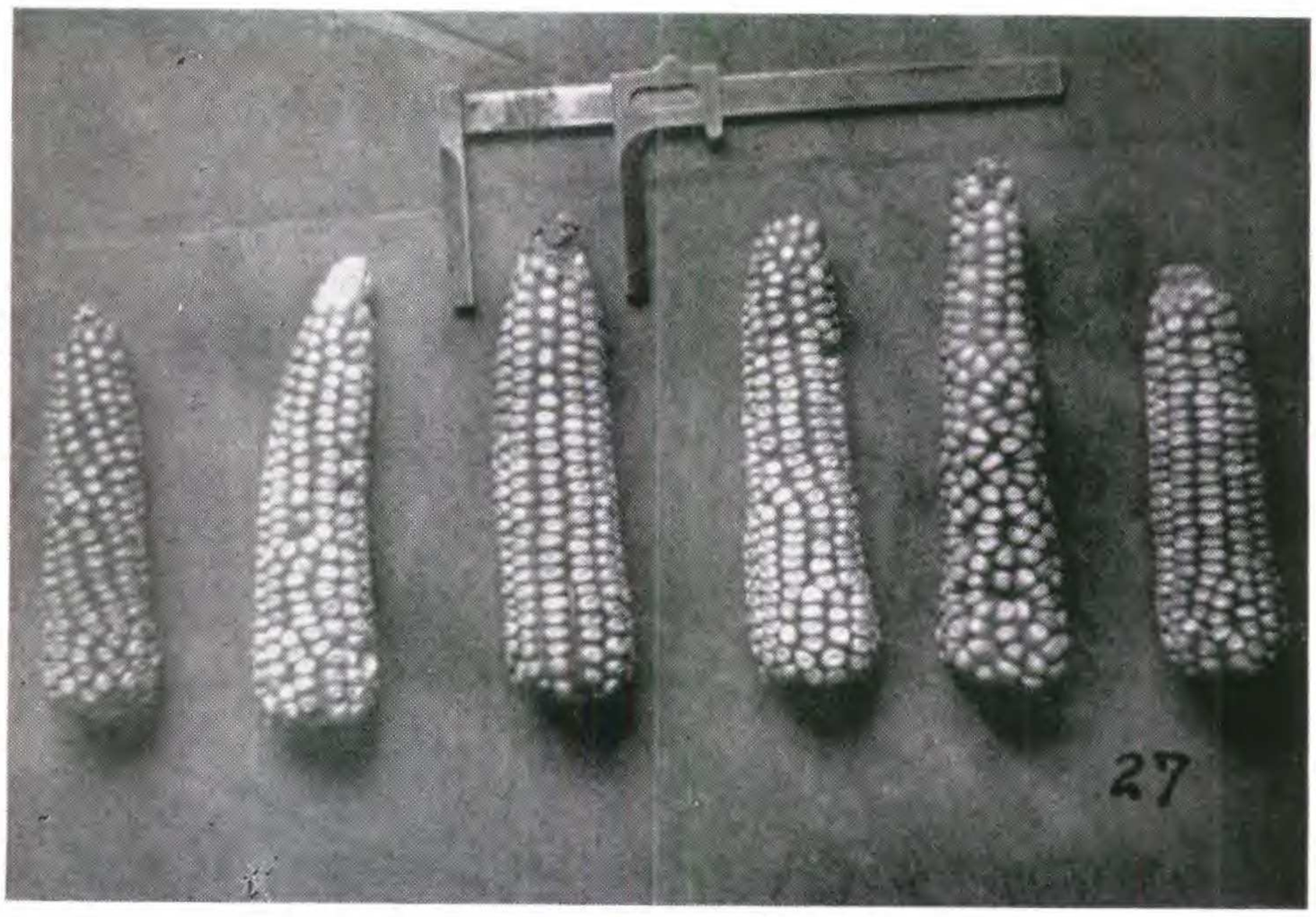
26. Tapalpa, Jalisco. *Maíz amarillo*

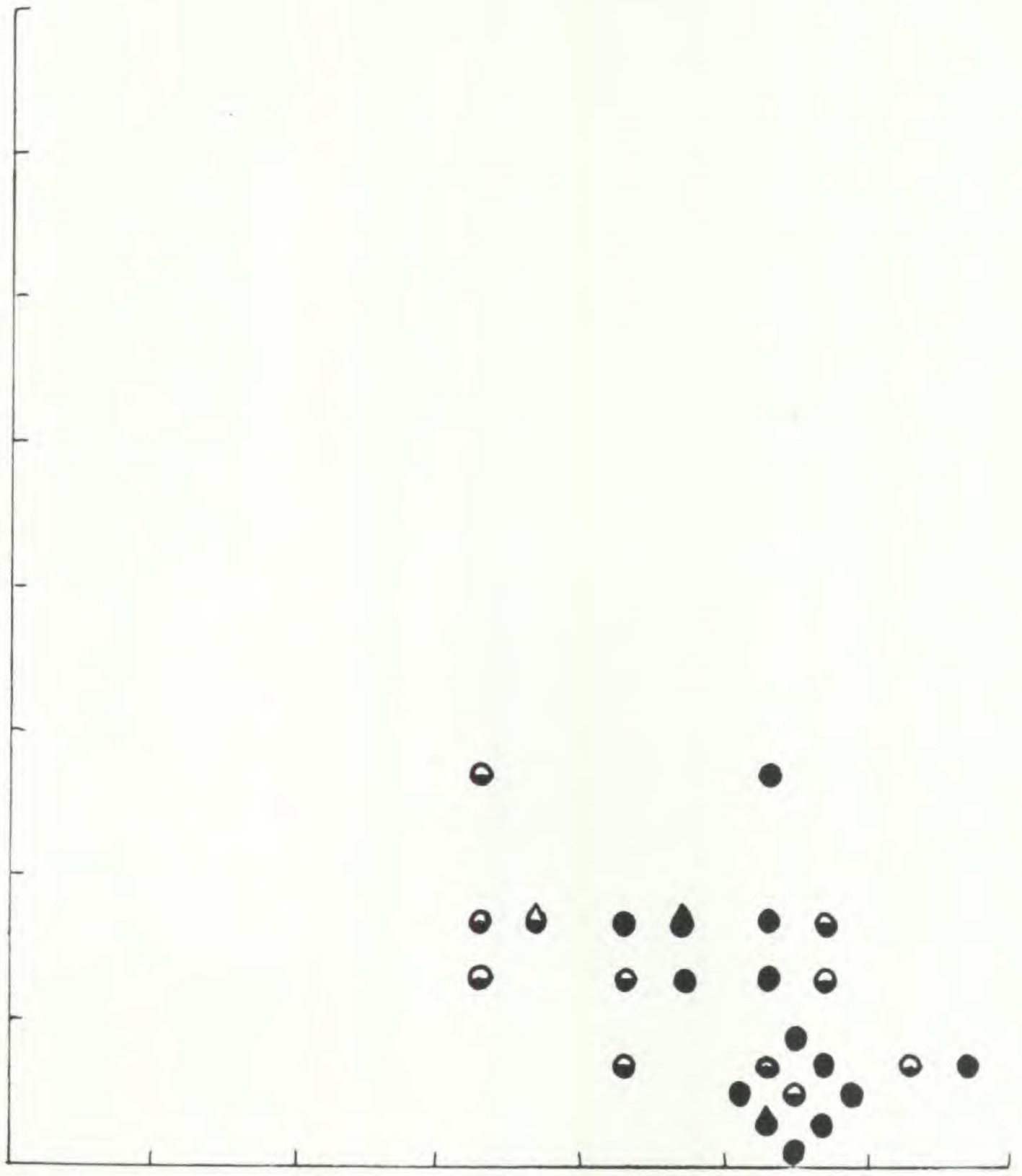
Tapalpa is a large and handsome town in the middle of a small, fertile, isolated plateau on the north flank of the Volcán de Colima. This variety was prevailingly yellow with many white kernels. Six of the ears had colored pericarp of some shade or other (various alleles of *P* and P^{cr}). Seven had red cobs.



27. Tapalpa, Jalisco. *Maíz amarillo del cerro*

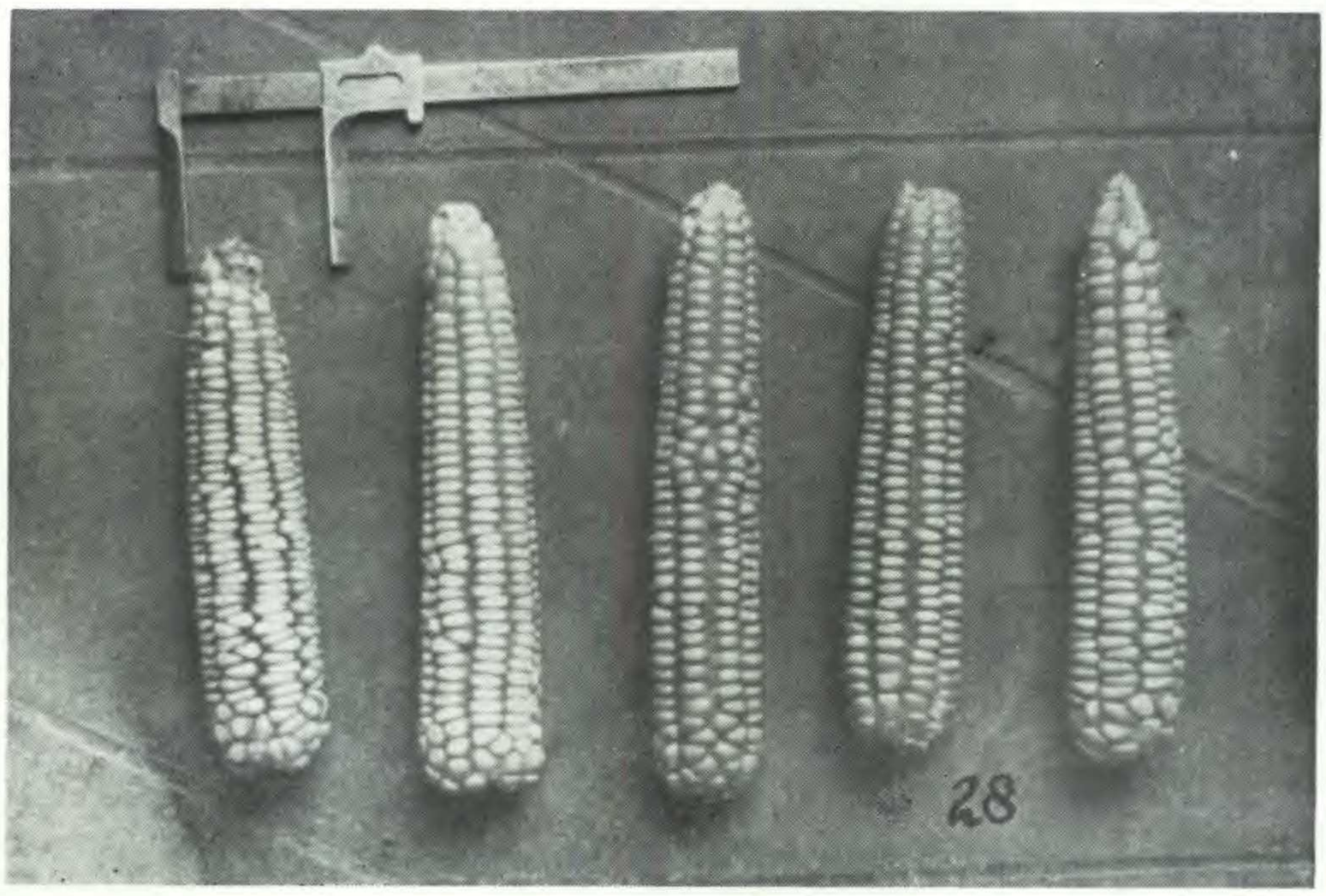
Prevailingly yellow with many white kernels. The majority of the ears have colored pericarp (*P* and P^{cr}) of various intensities.

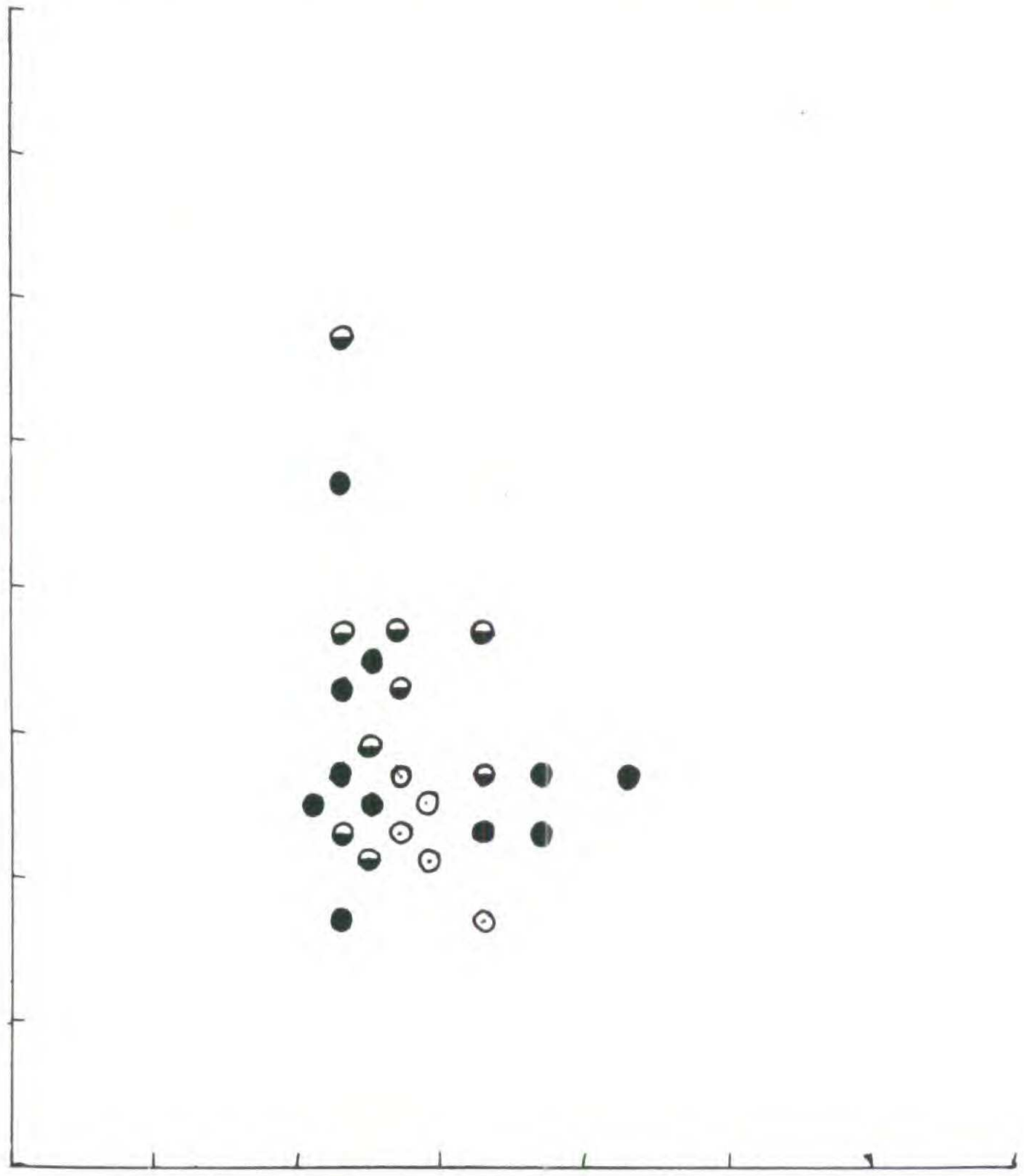




28. Tapalpa, Jalisco. *Maíz amarillo de tierra más templada*

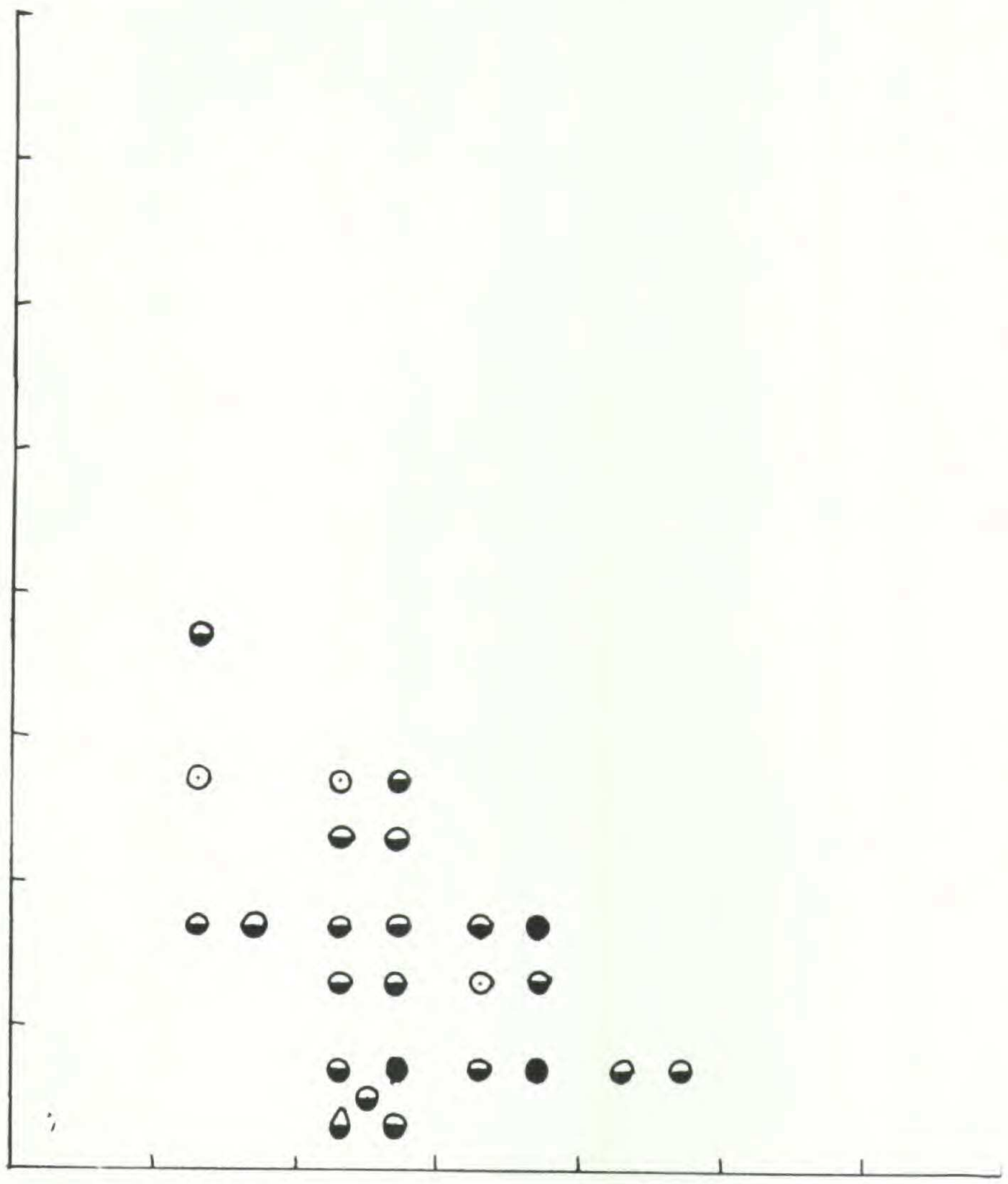
As the name indicates, grown on fields well below the town, hence with a longer season. Light yellow and white, mostly red-cobbed.





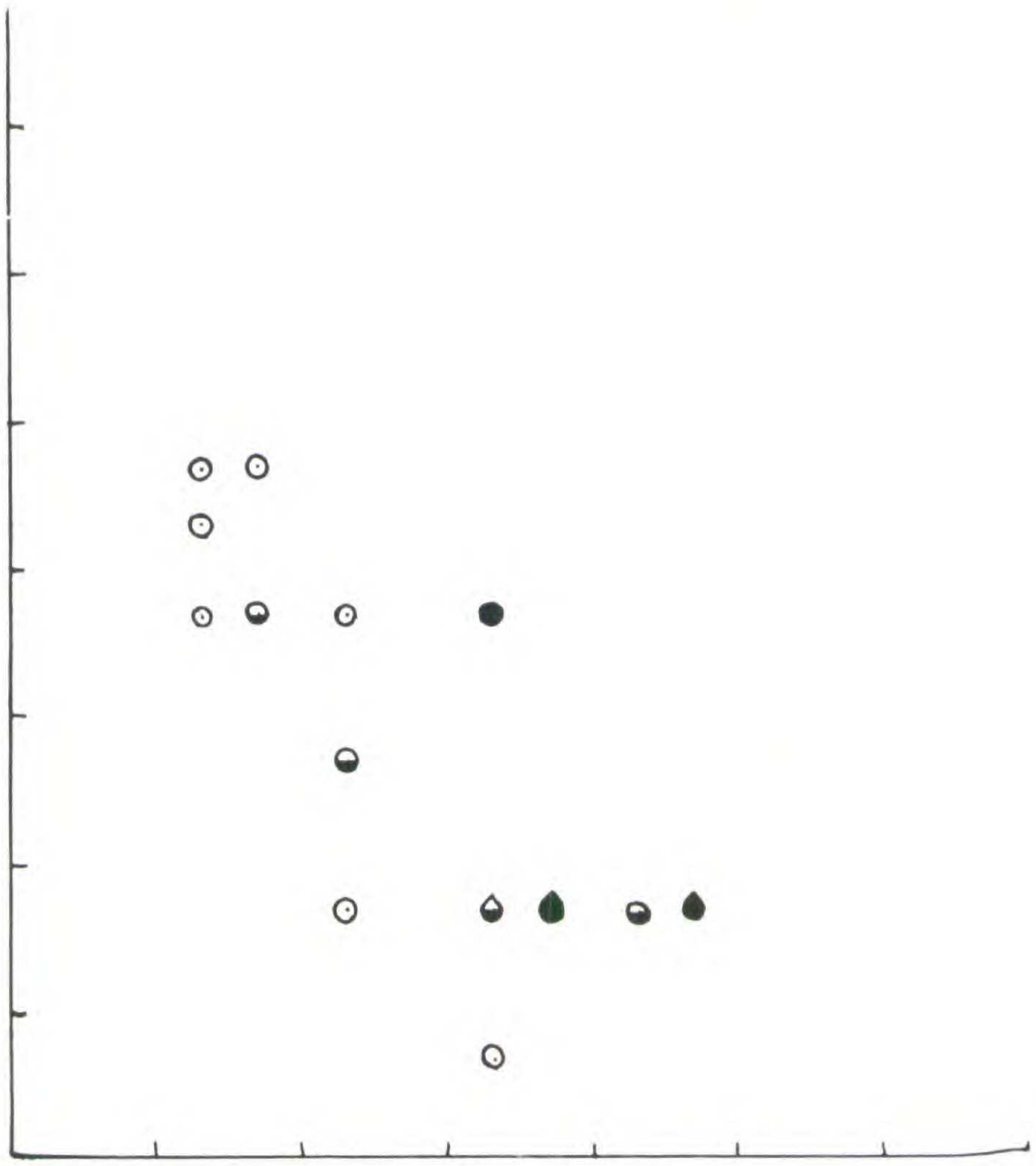
29. Tapalpa, Jalisco. *Maíz criollo blanco*

White, a few of the ears with a few bright yellow kernels. One ear *Pcr*.



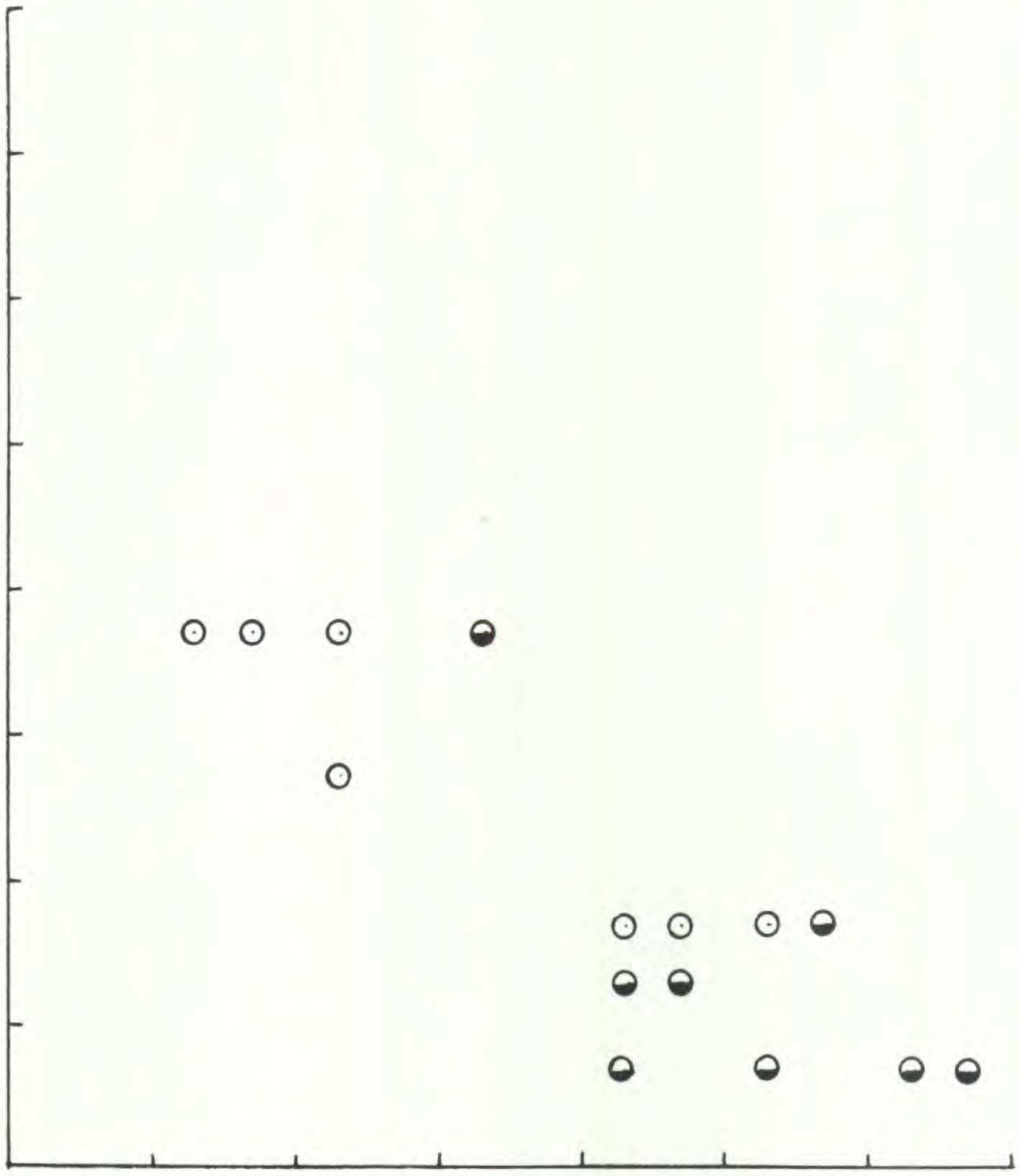
30. Tapalpa, Jalisco. *Maíz espiga blanca*

Unlike most of the preceding varieties, this one does not have a brightly colored tassel. Prevailingly yellow, a few of the ears with white kernels and a few with colored pericarp *(P* and P^{cr}*)*. Cobs white or a very faint red. The ears of this variety were similar to those illustrated in pl. 6, particularly those at the bottom and the top of the plate.



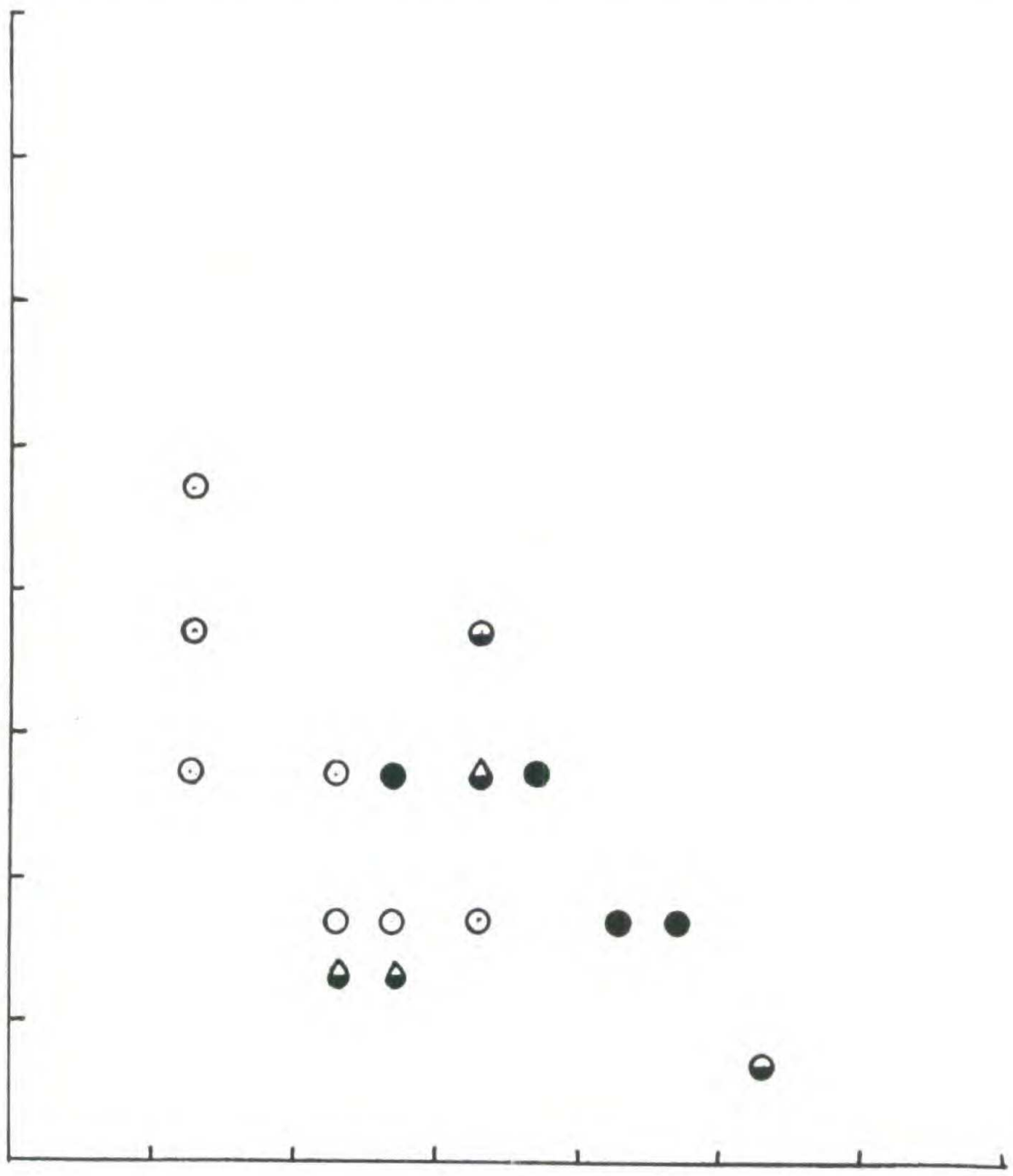
31. Coalcomán area, Michoacán. From clearing A.

This and the two following samples were sent me by Sr. F. Vargas Tentory, a member of a cultural mission to backward areas. These three collections were made in three different forest clearings in the Coalcomán area in western Michoacán. The 14- and 16-rowed specimens in each collection are very similar to *maiz reventador;* the remainder of the collections looks like crosses between that and typical Mexican Narrow Ear varieties.



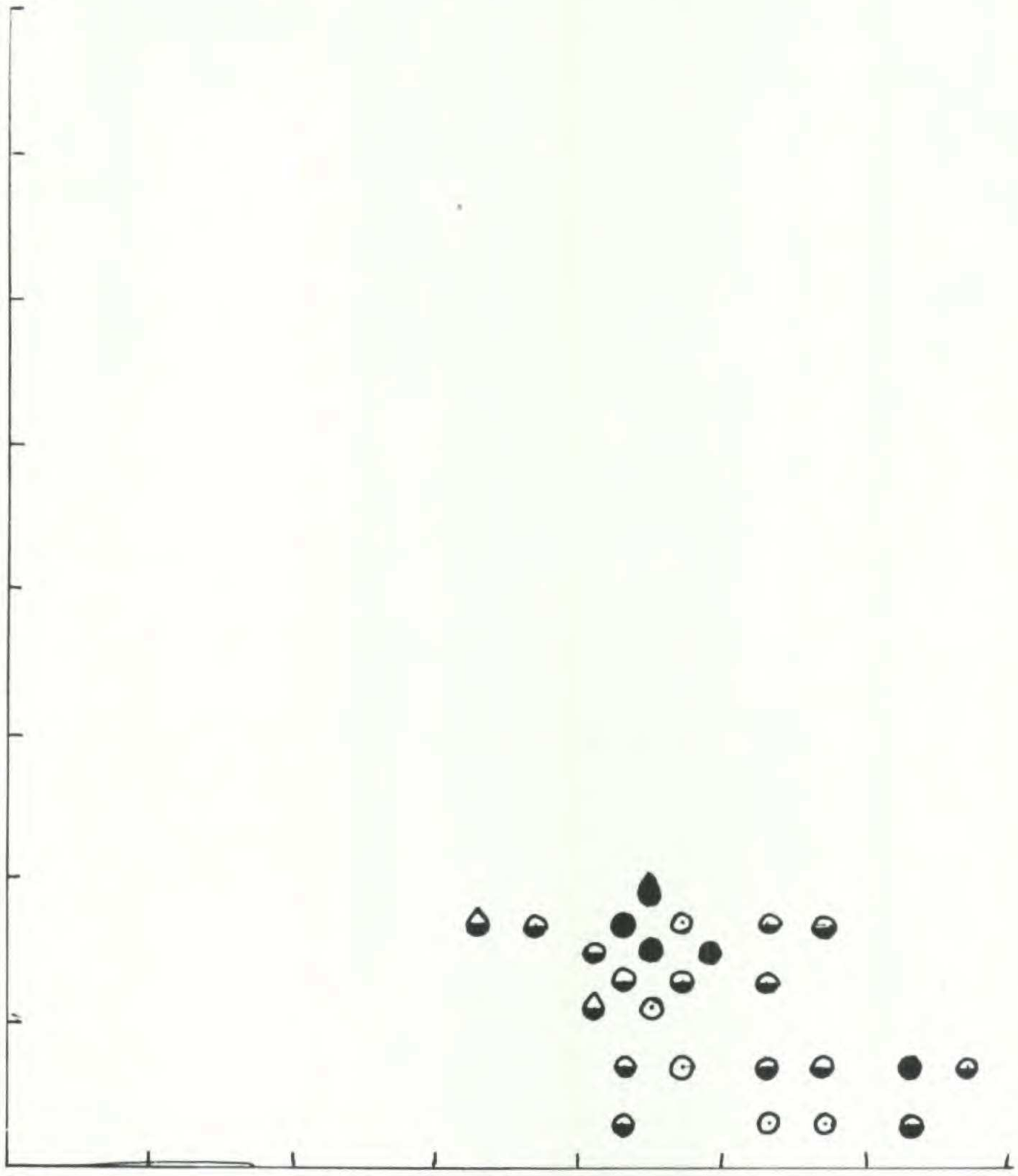
32. Coalcomán area, Michoacán. Clearing B.

See notes on the previous collection. These collections were variable as to color. A few had dark red pericarp (strong allele of *P*), a few had colored aleurone *(Pr)*, and several showed a crowned pericarp *(P^{cr})*. The rest were white and yellow. One of the *Pr* ears had a single white kernel, indicating the presence of dominant white *(C^{i})*.



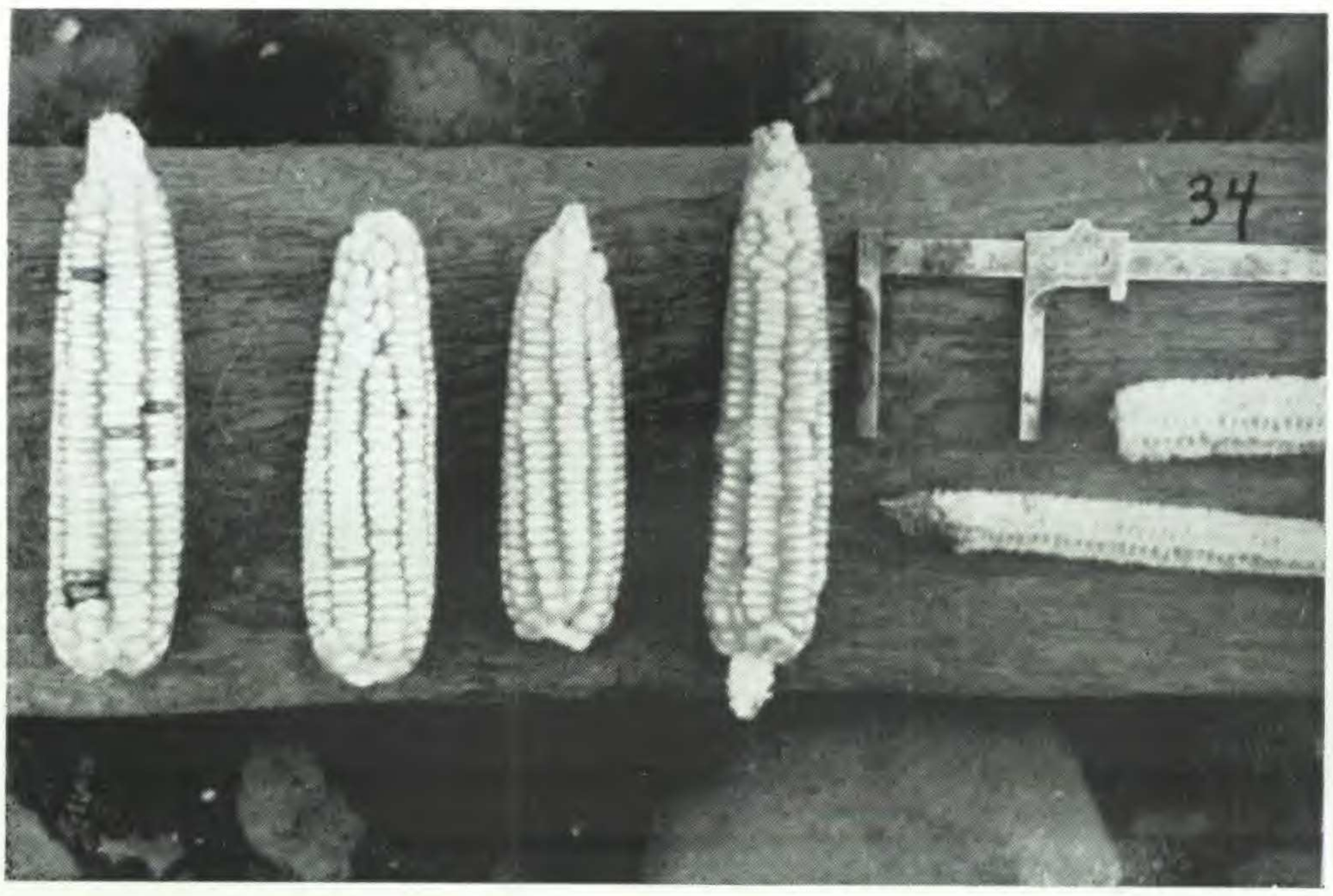
33. Coalcomán area, Michoacán. Clearing C.

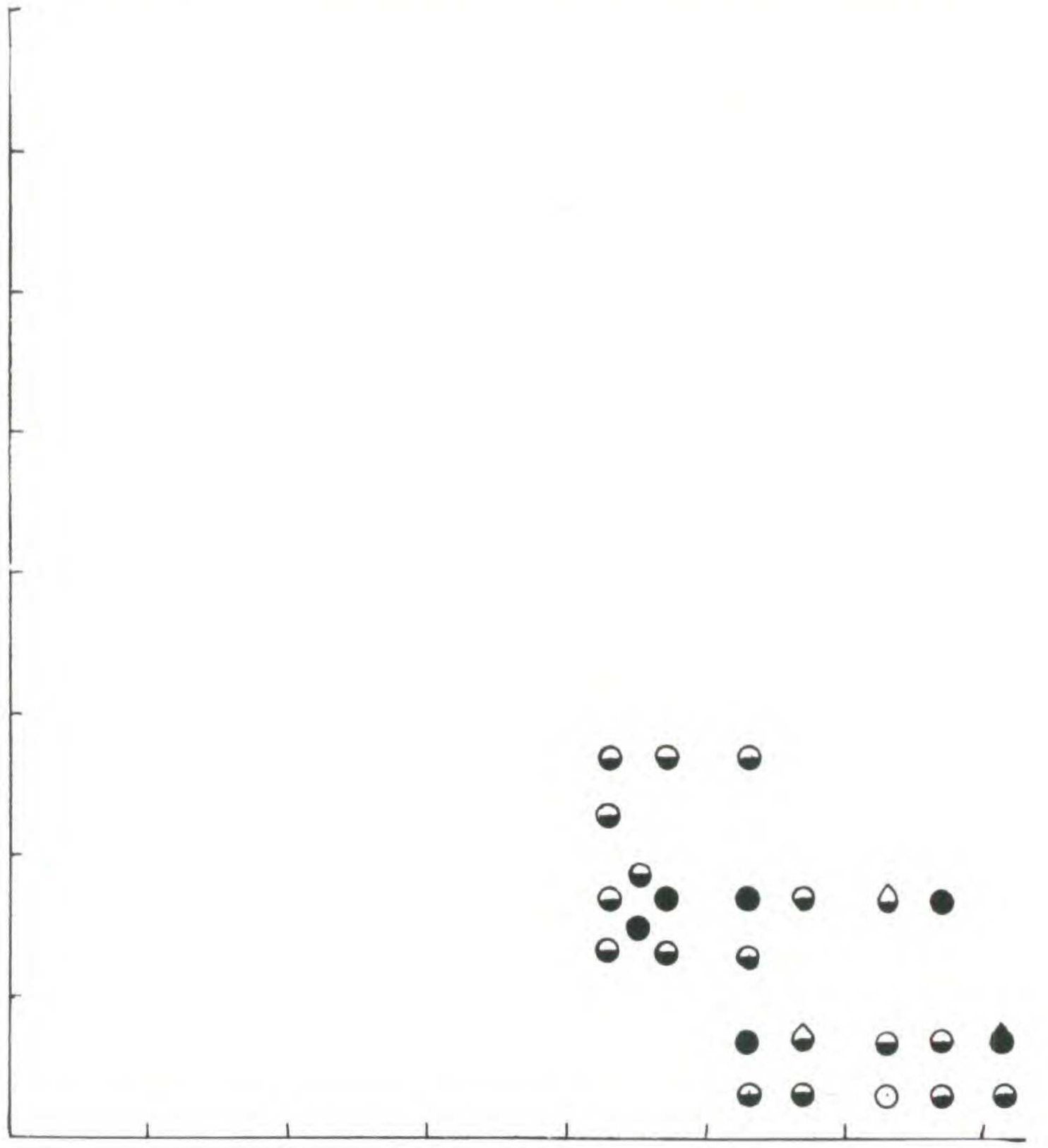
See notes on two previous collections. These three collections do not represent samples from a single field, as do most of the examples in this Appendix, but are from all the varieties grown in each clearing.



34. Apatzingán, Michoacán. *Maíz amarillo*

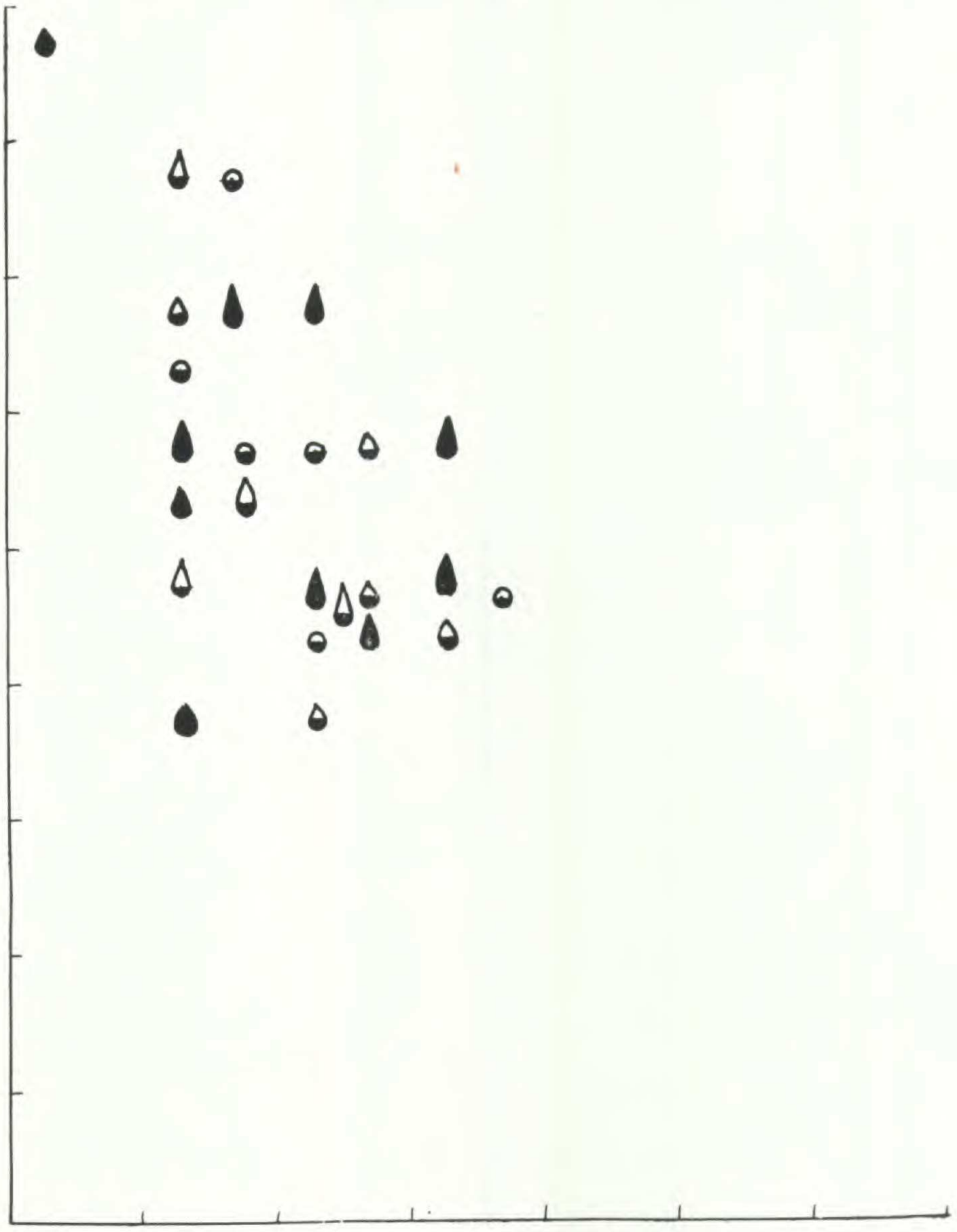
Prevailingly yellow. Two ears had white kernels. Eight of the ears had few to many kernels with colored aleurone *(Pr)*. One had tan pericarp.





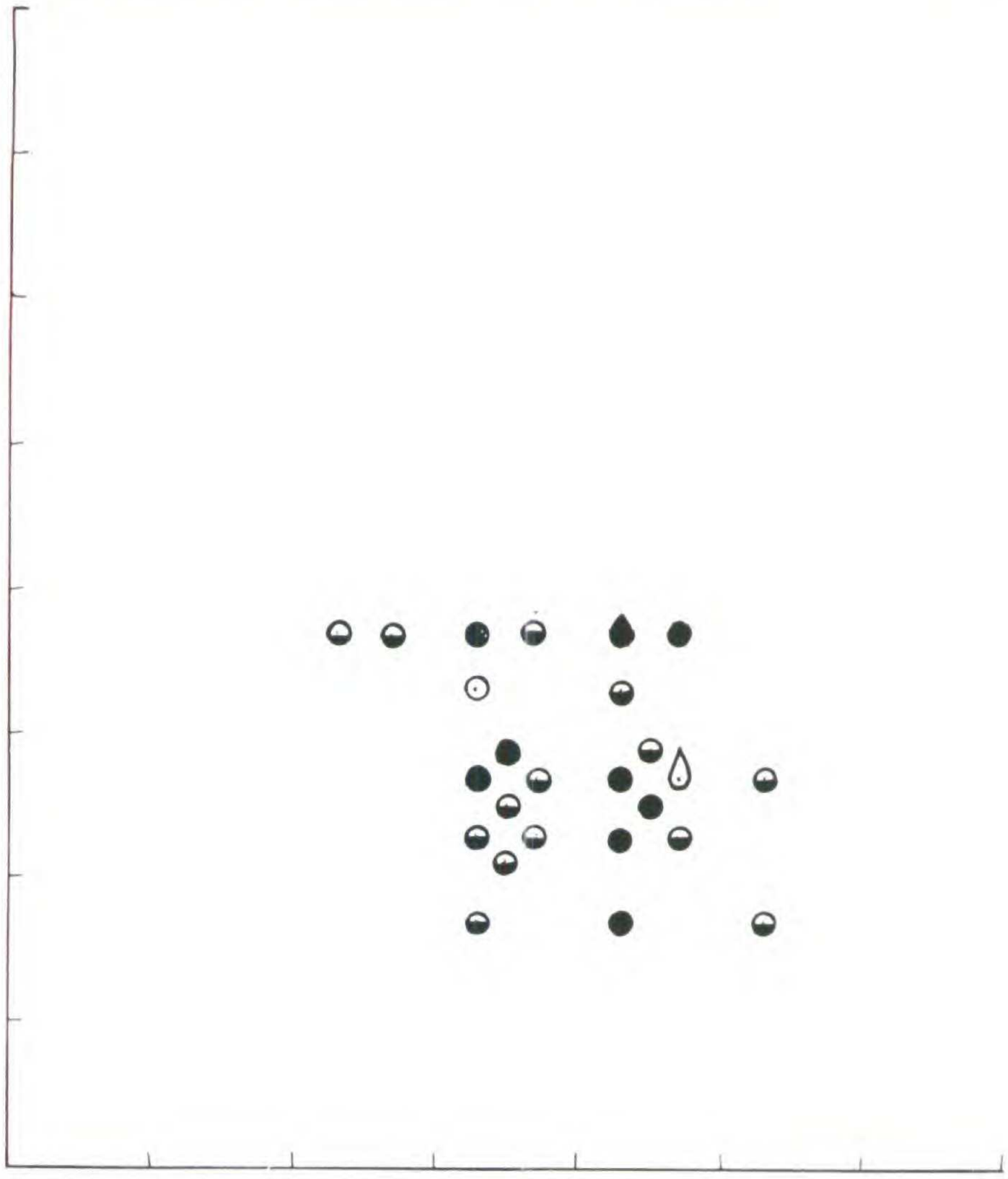
35. Apatzingán, Michoacán. *Maíz amarillo*

Prevailingly yellow. Eleven of the ears had white kernels; one had a tan pericarp.



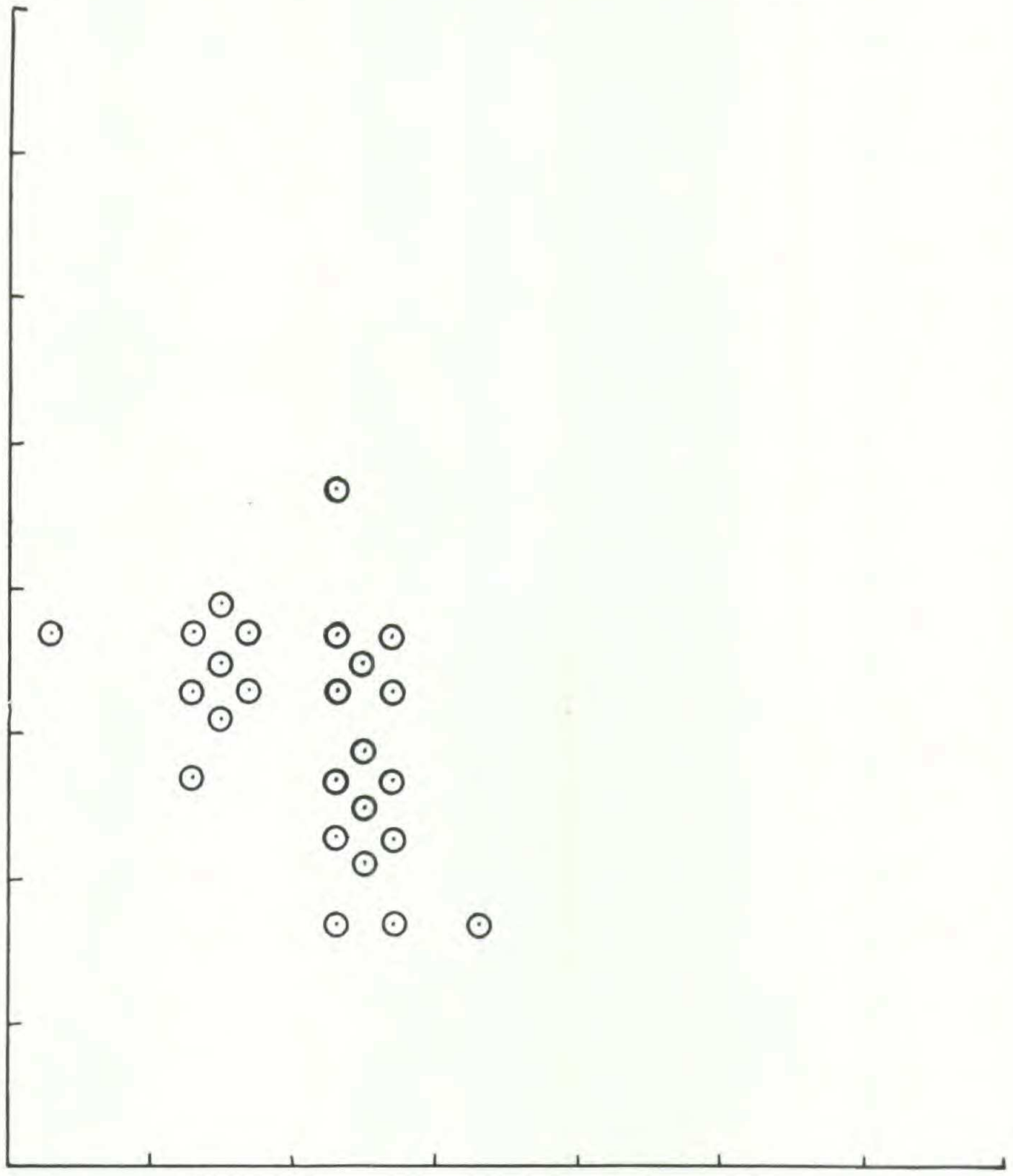
36. Jiquilpan, Michoacán. *Maíz pipitillo*

Prevailingly white, seven of the ears showing yellow kernels. Five ears had a few kernels with colored aleurone but they were all very faint in color. Apparently the white of this variety is almost dominant. The name *pipitillo* usually denotes a large-eared, many-rowed variety with long, more or less pointed kernels, dented and wrinkled below the point.



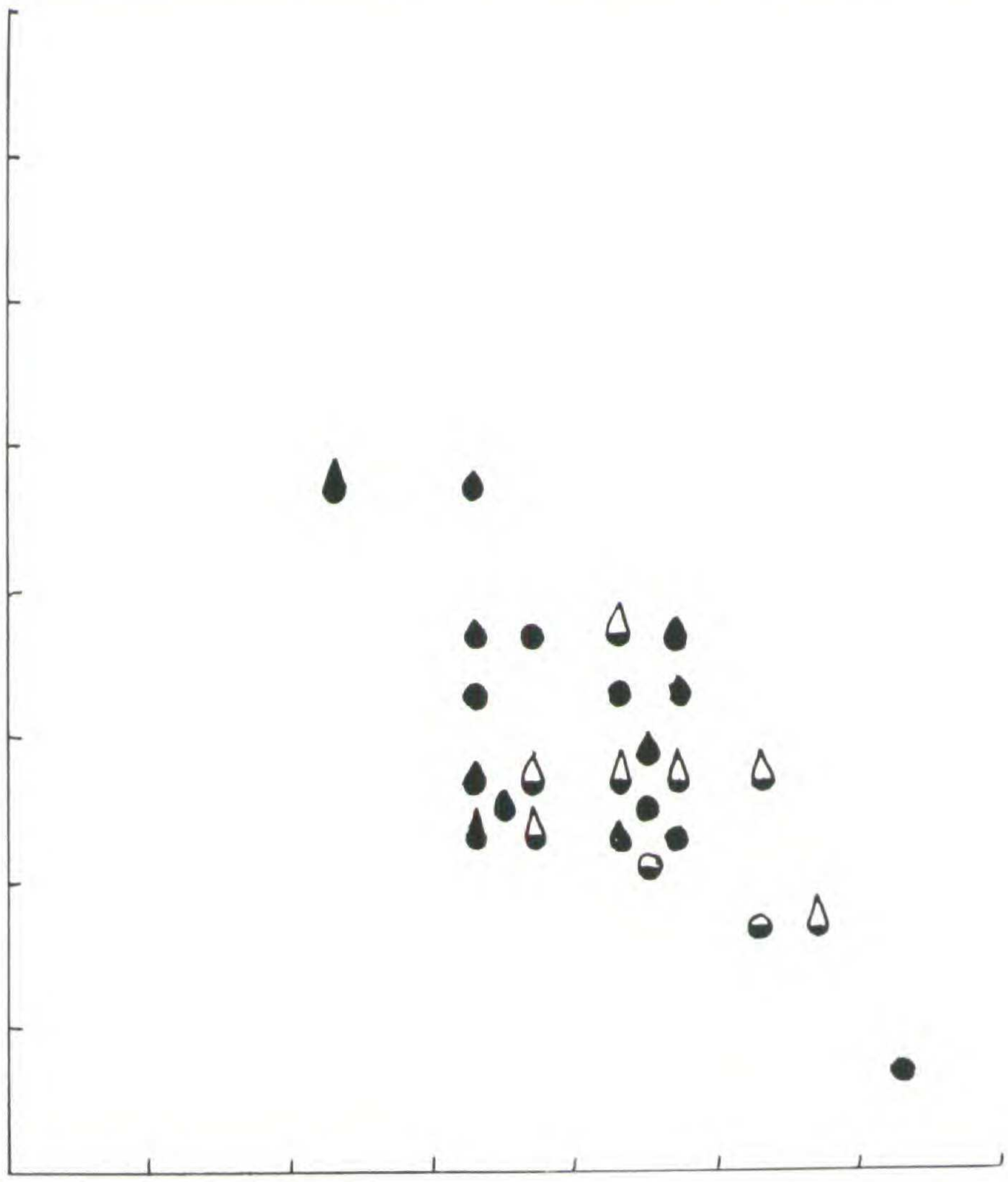
37. Jiquilpan, Michoacán. *Maíz amarillo*

Raised at La Cofradia in the hills above Jiquilpan. Prevailingly yellow. A few ears had white kernels, four had a few kernels with colored aleurone *(Pr)*. Two ears had faint pericarp color (a low allele of *P*).



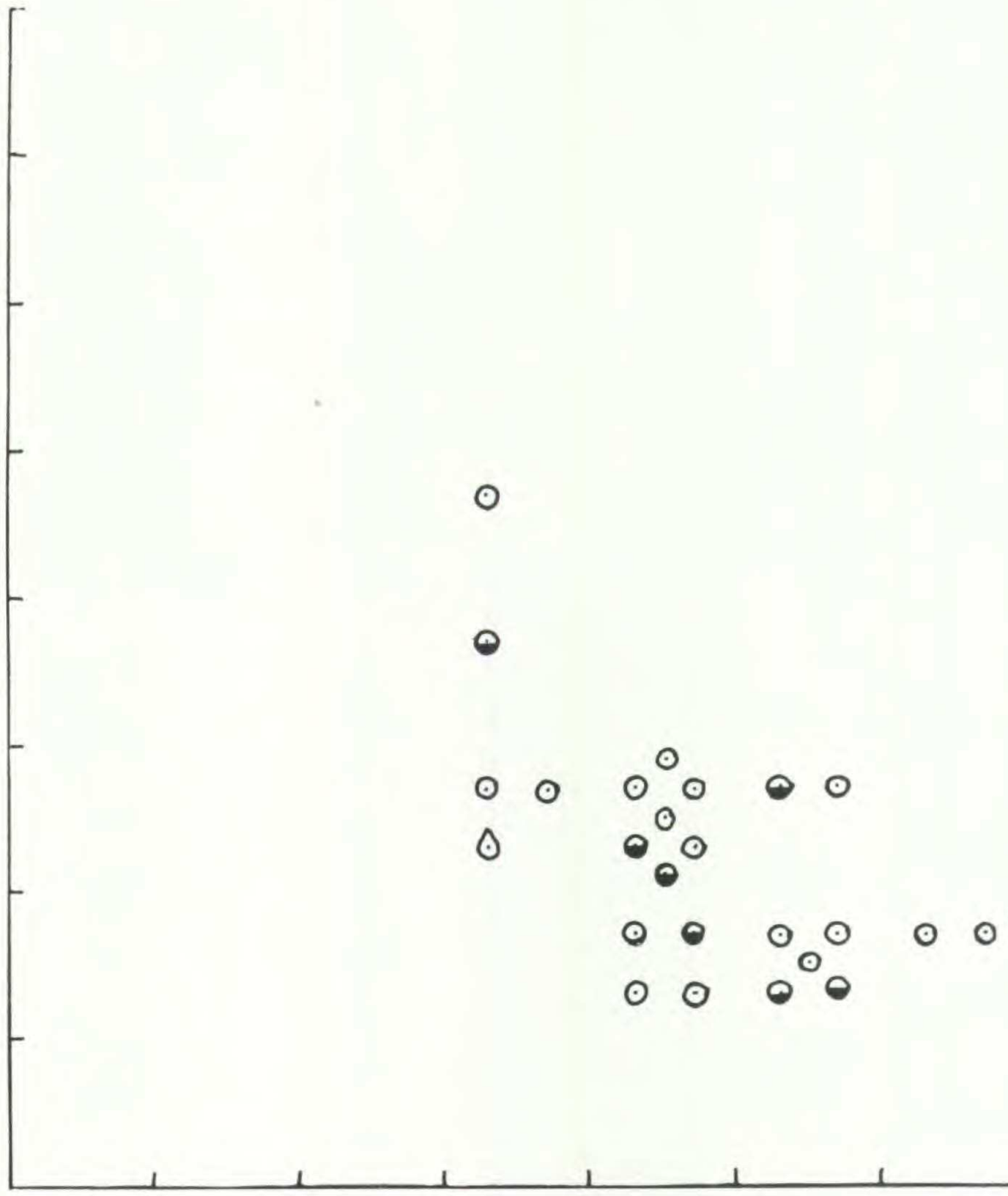
38. Jiquilpan, Michoacán. *Maíz rosquera*

This variety was identical with the *maíz reventador* of near-by Jalisco and not at all like the pointed popcorn sometimes called by the same name near Mexico City. All the ears bore both yellow and white kernels. Six had a few kernels with colored aleurone (both *Pr* and *pr*).



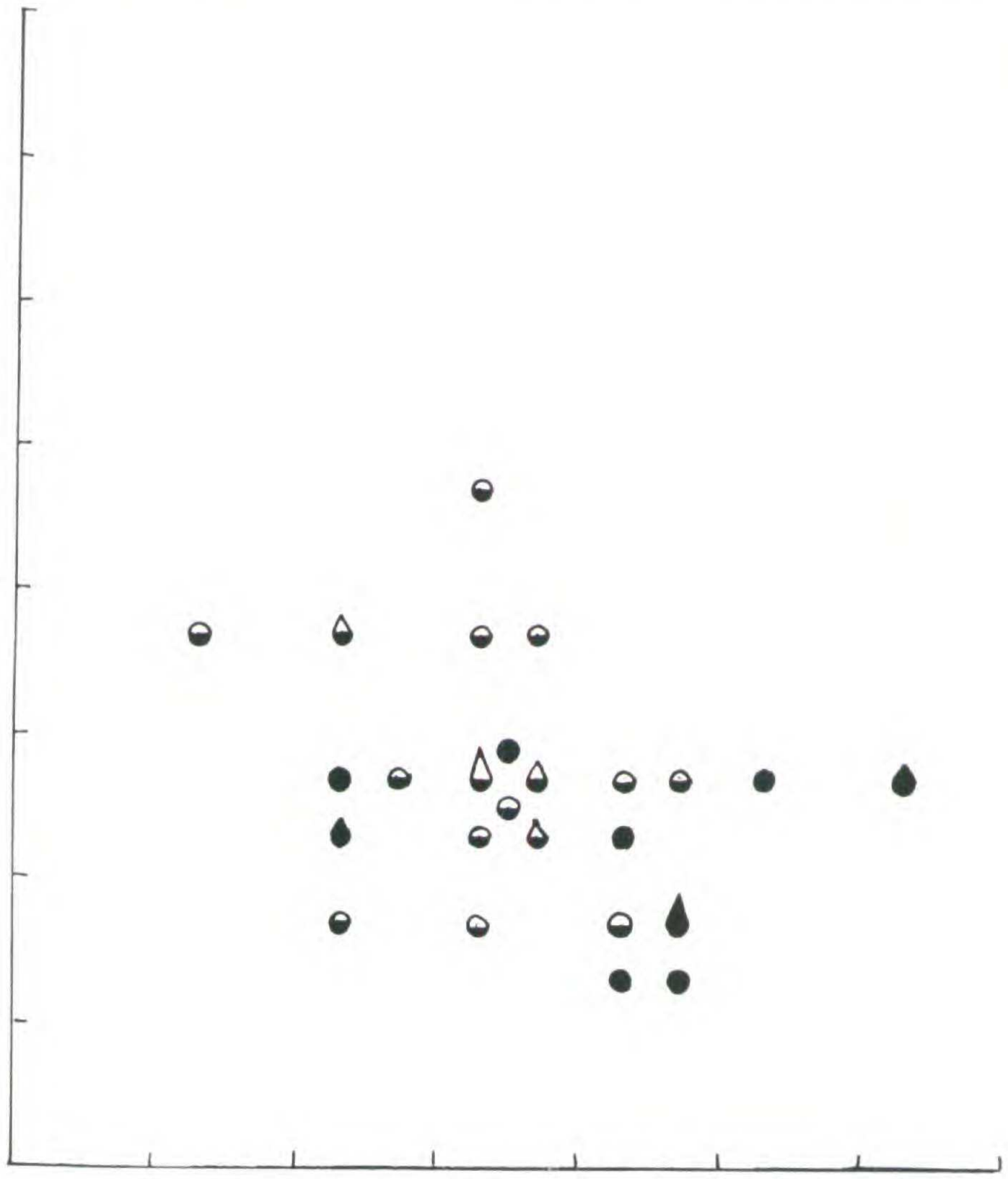
39. Jiquilpan, Michoacán. *Maíz grueso*

Prevailingly white. A majority of the ears had a few to many yellow kernels. Five had kernels with colored aleurone *(Pr)*. One ear was flushed with brilliant color (allele of *R*).



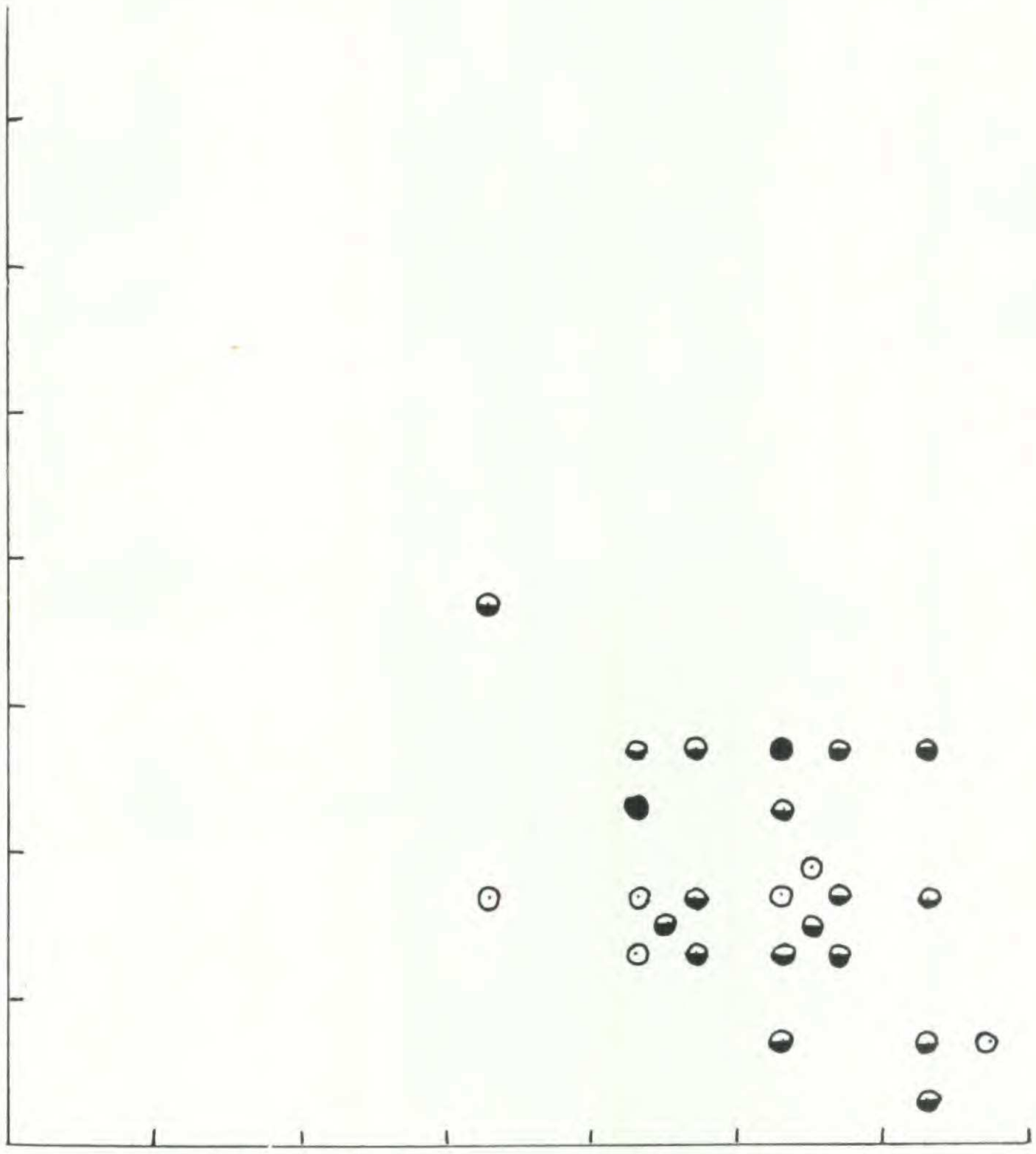
40. Jiquilpan, Michoacán. *Maíz negro*

Prevailingly dark blue (colored aleurone *Pr*). Several of the ears were segregating for *pr*. Nine of the ears showed white kernels but in such small numbers that it must have been due to pollination with dominant white (C^i) rather than segregation. Note how much wider-seeded and fewer-rowed this variety is, on the average, than the other samples from Jiquilpan. See discussion under "elote" varieties.



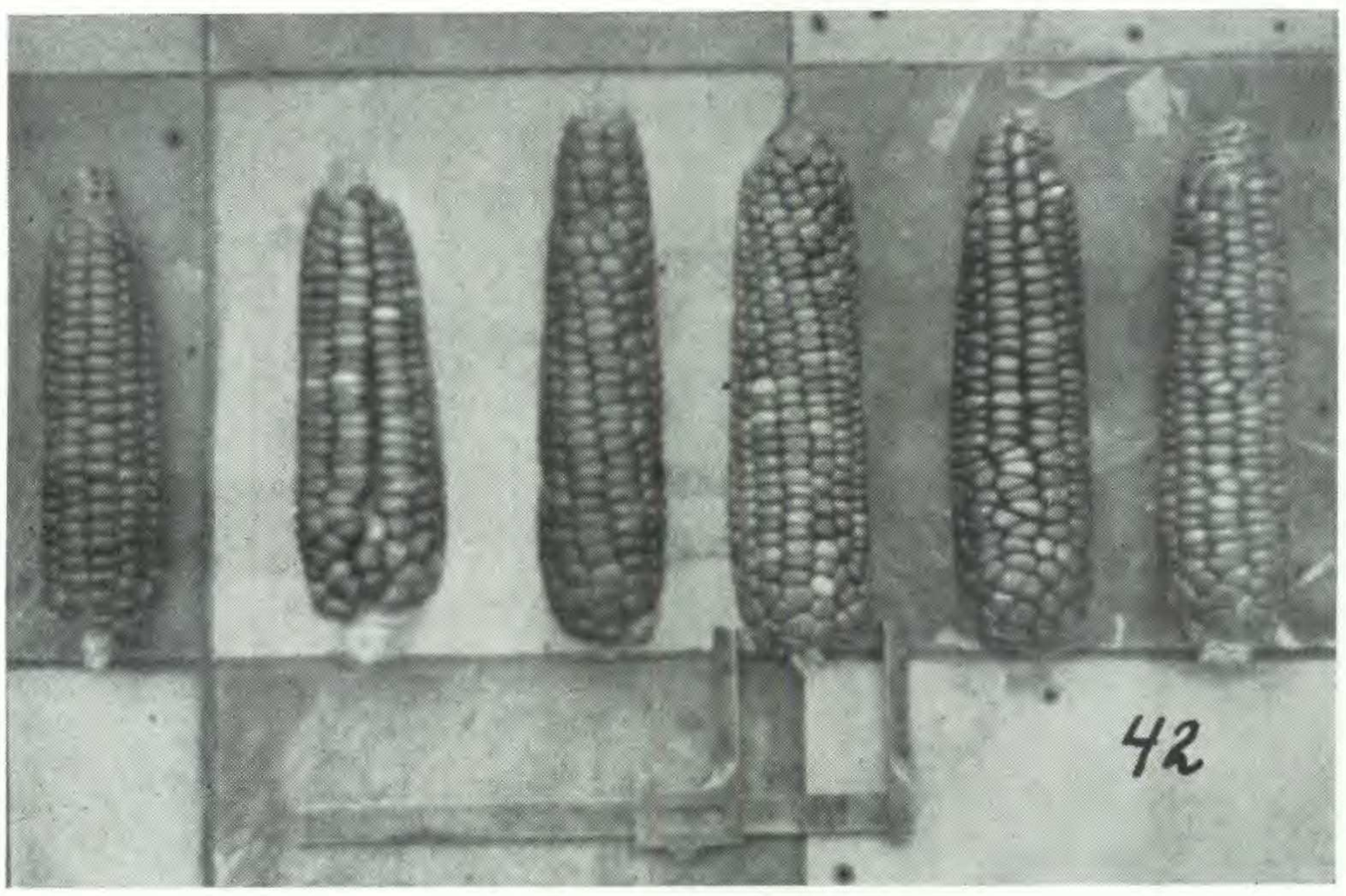
41. Uruapan, Michoacán. *Maíz criollo*

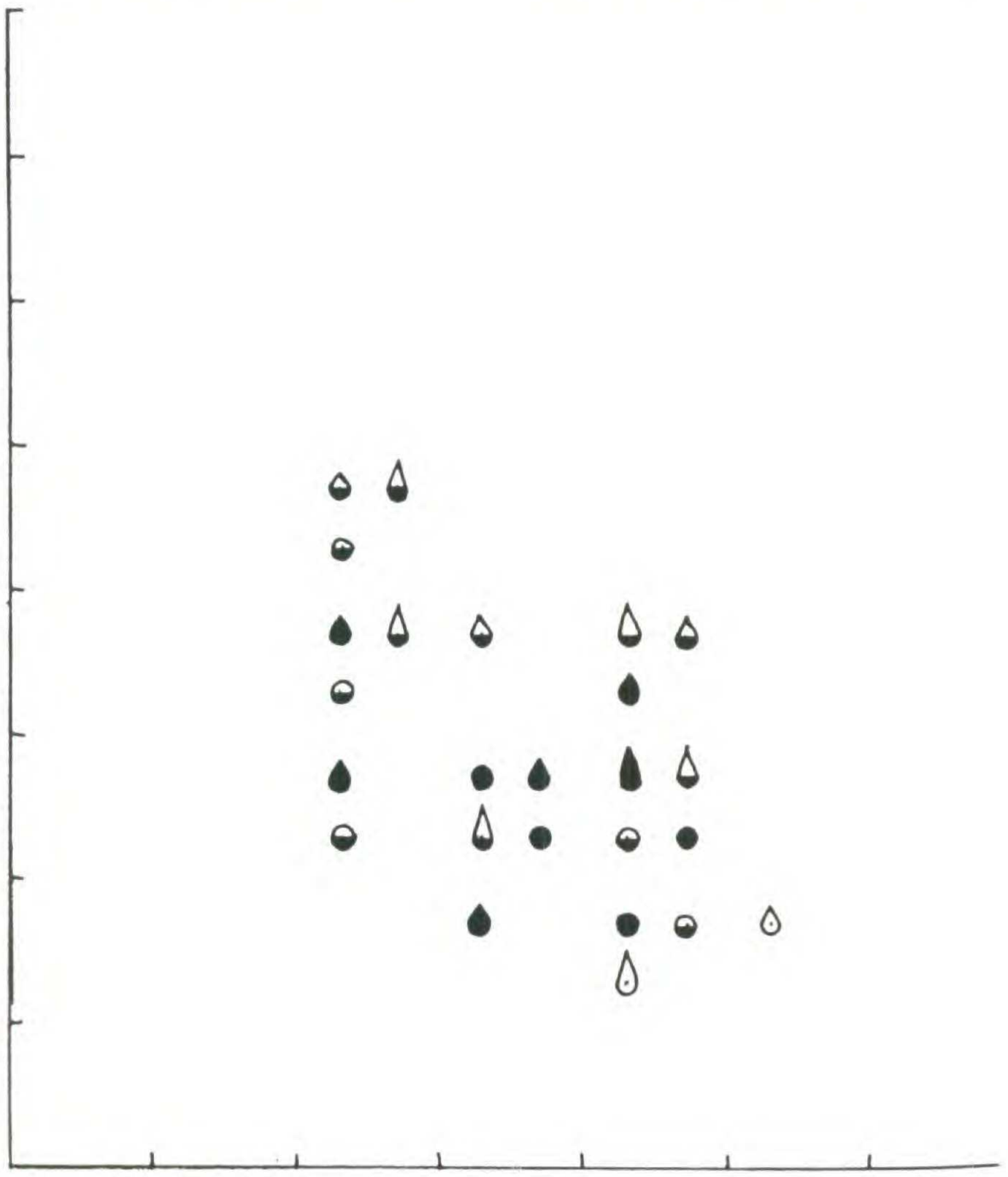
Prevailingly light yellow. Two ears with a few white kernels; two with a few kernels with colored aleurone (one *Pr* and one *pr*).



42. Uruapan, Michoacán. *Maíz breve.*

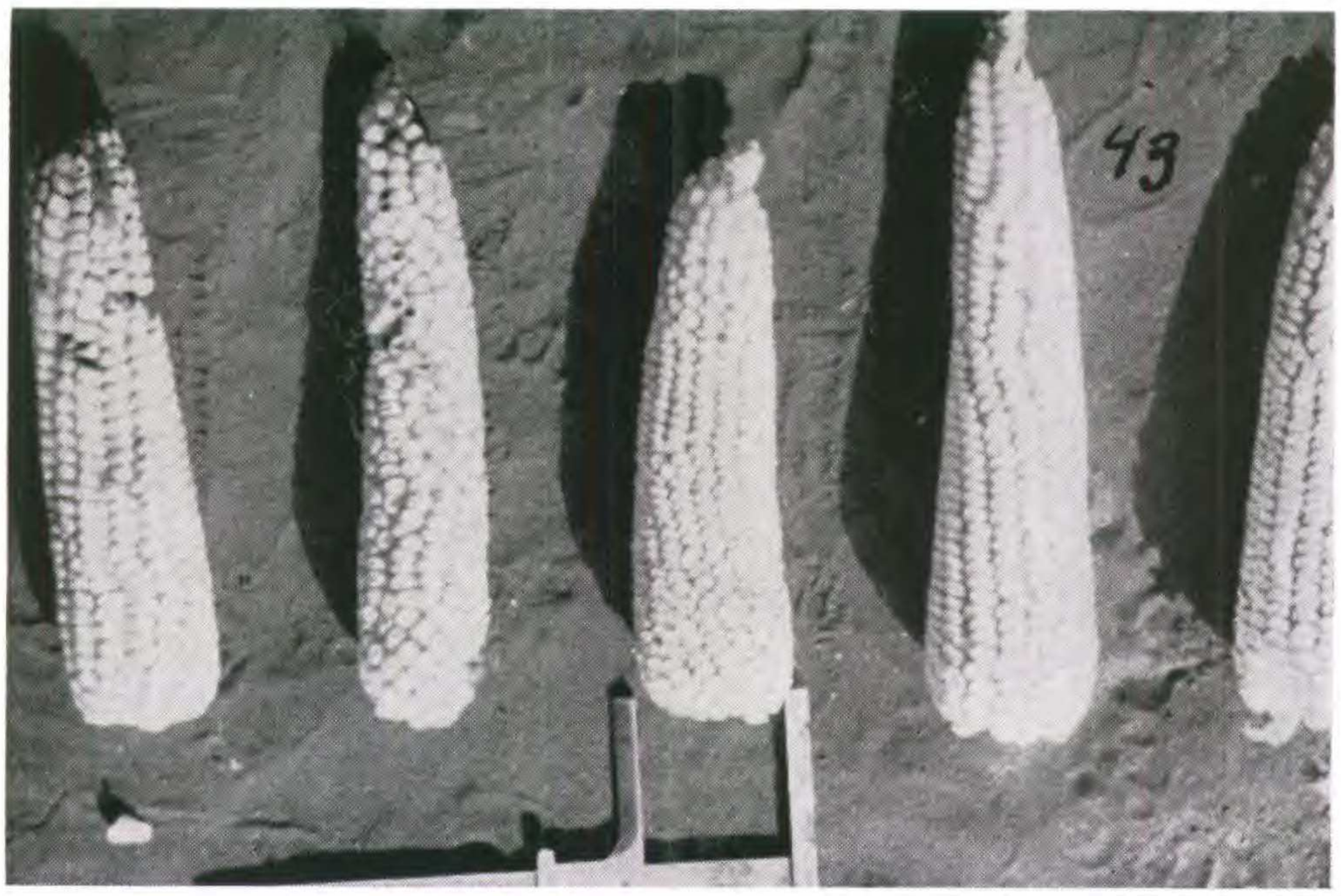
Prevailingly reddish aleurone *(pr)*, though a majority of the ears show few to many dark kernels *(Pr)* and one was segregating. Seven had colored pericarp *(P* and P^{cr}*)*.

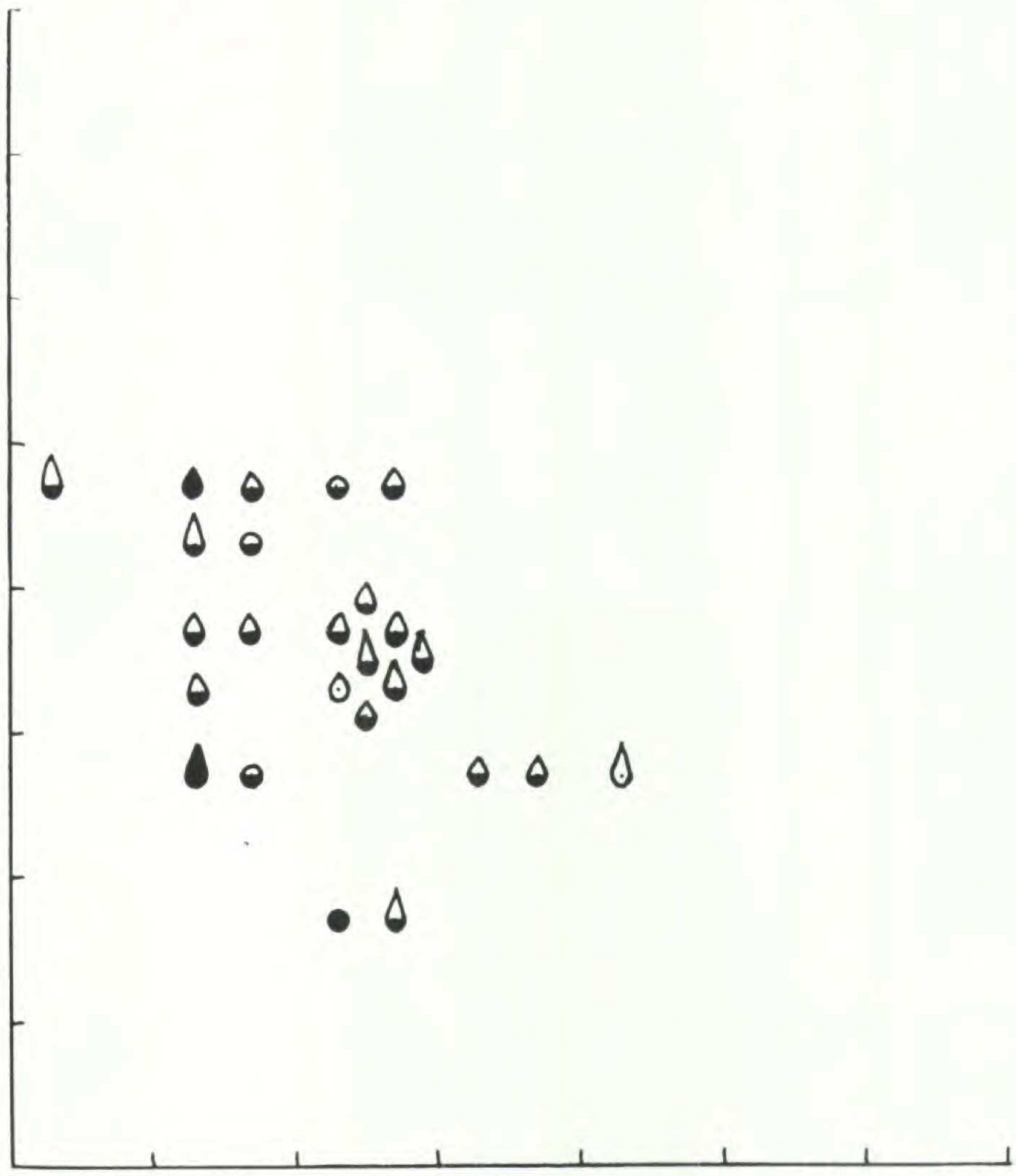




43. San Lorenzo, Michoacán. *Maíz del cerro*

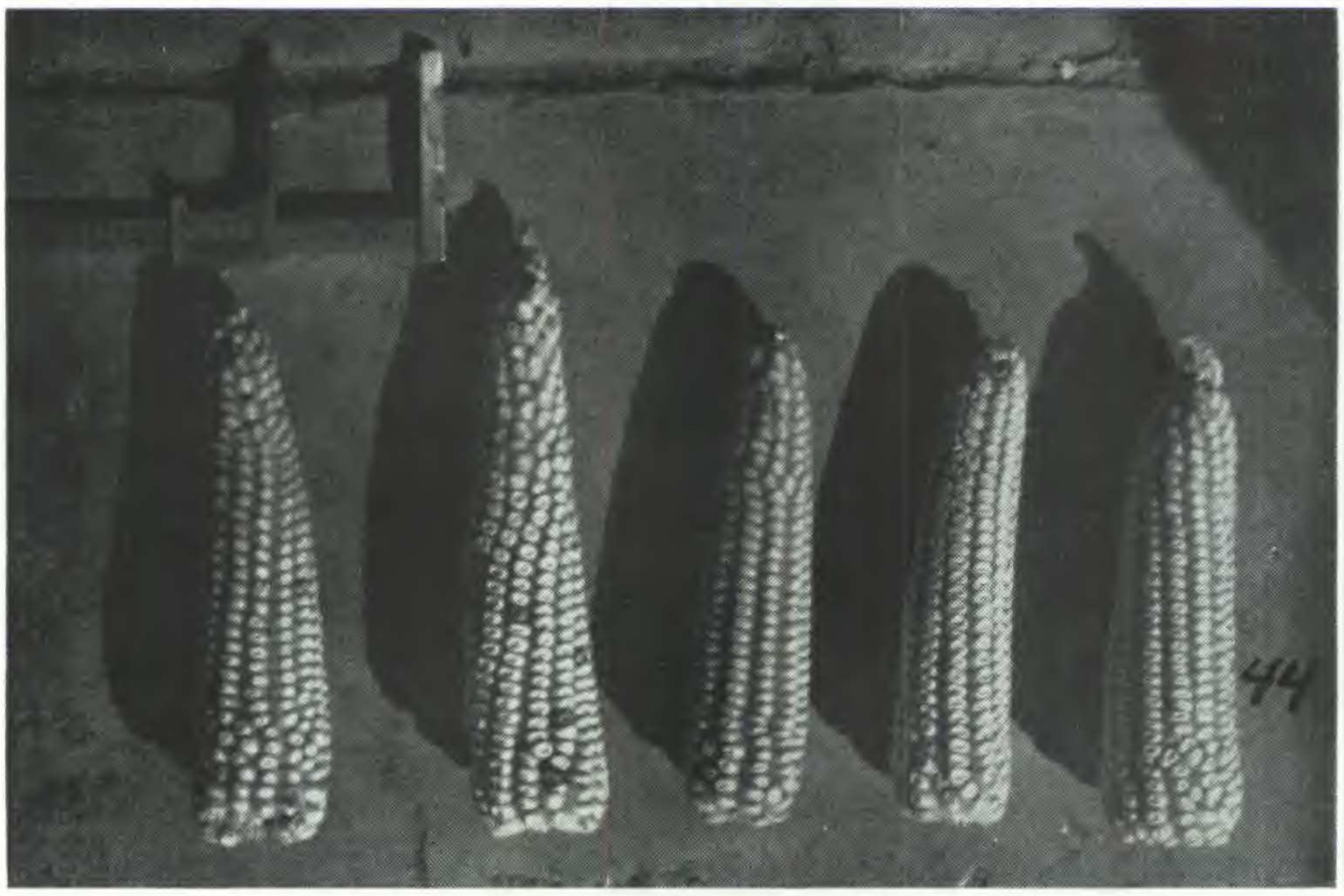
Prevailingly white and yellow. A few ears with dark aleurone *(Pr)* on a few kernels. Two ears flushed pink (allele of *R*?) Crop stunted by new volcanic ash.

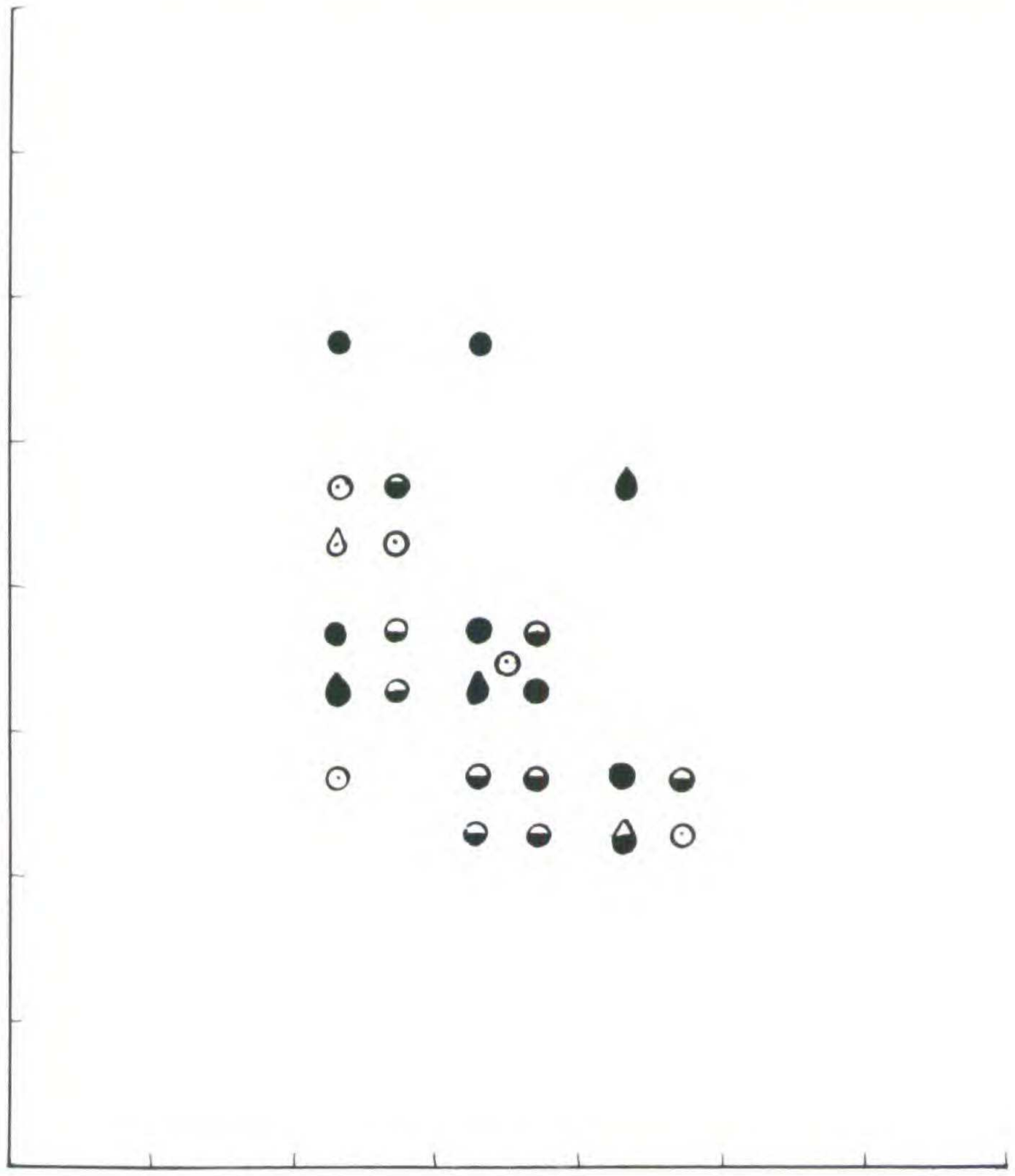




44. Cherán, Michoacán. *Maíz tulekenio*

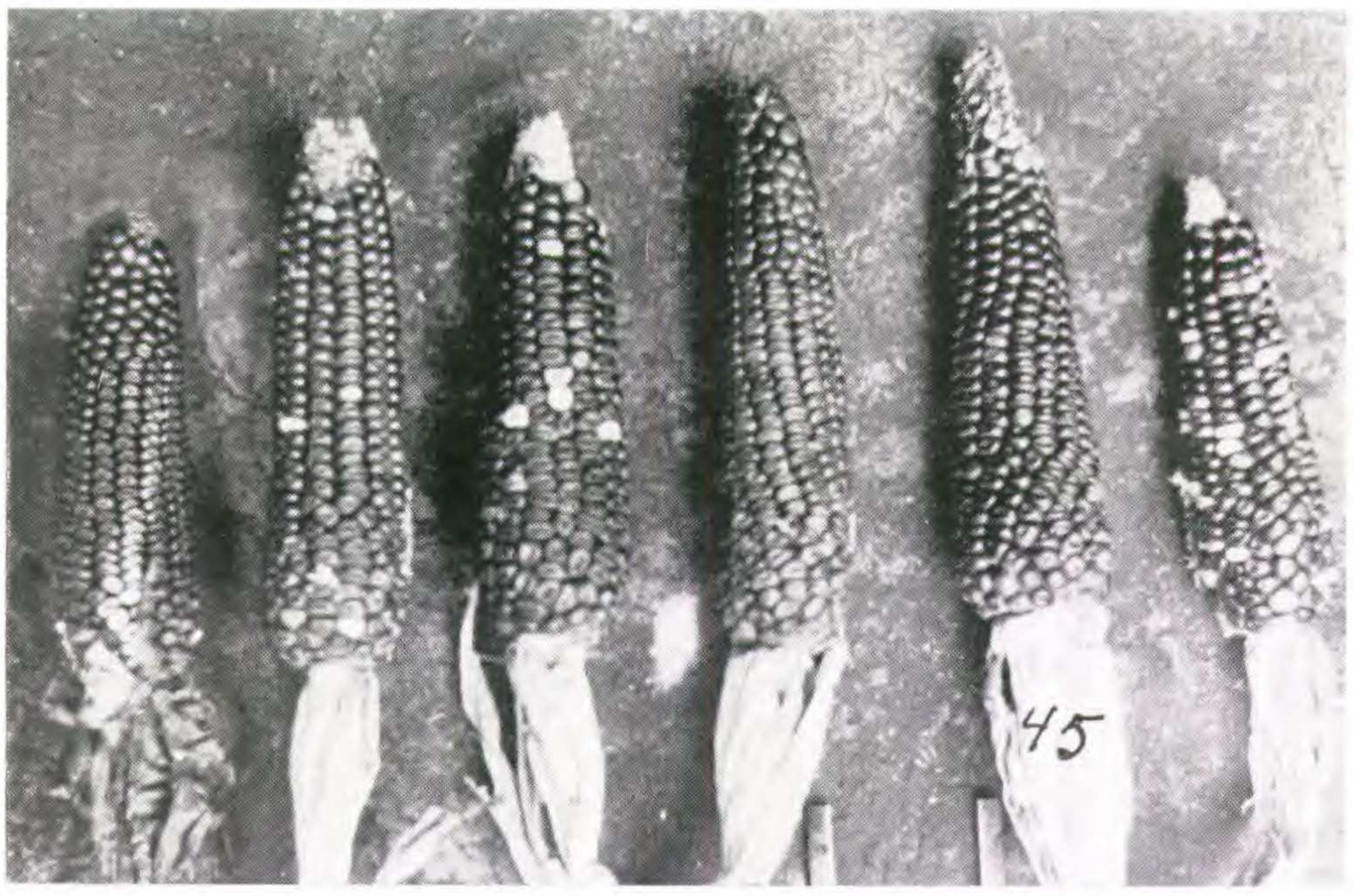
White and yellow in various mixtures. Seven of the ears had bright pink or red in the pericarp (various alleles of *R*?). Six ears had a few kernels with dark aleurone *(Pr)*.

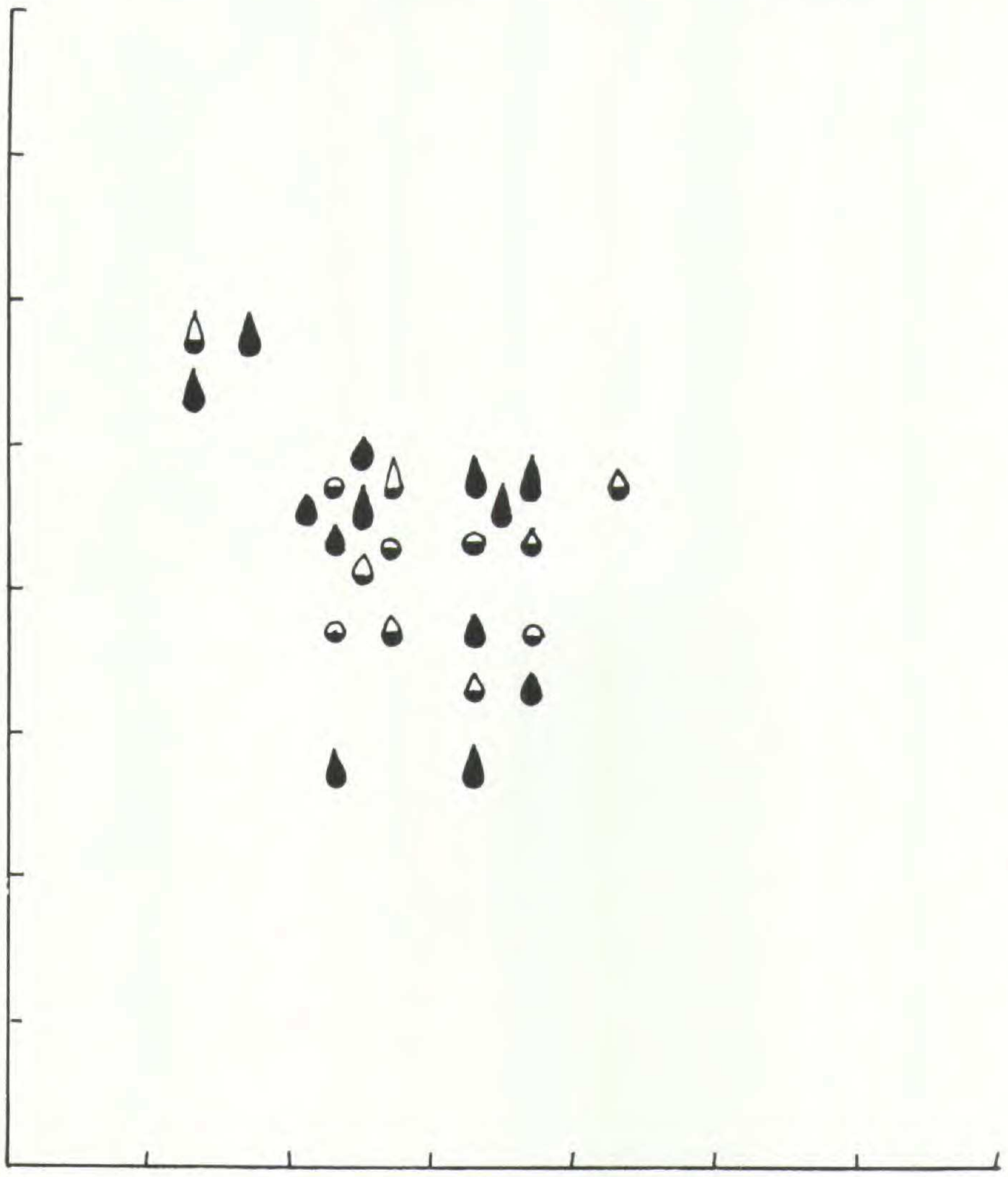




45. Cherán, Michoacán. *Maíz pinto*

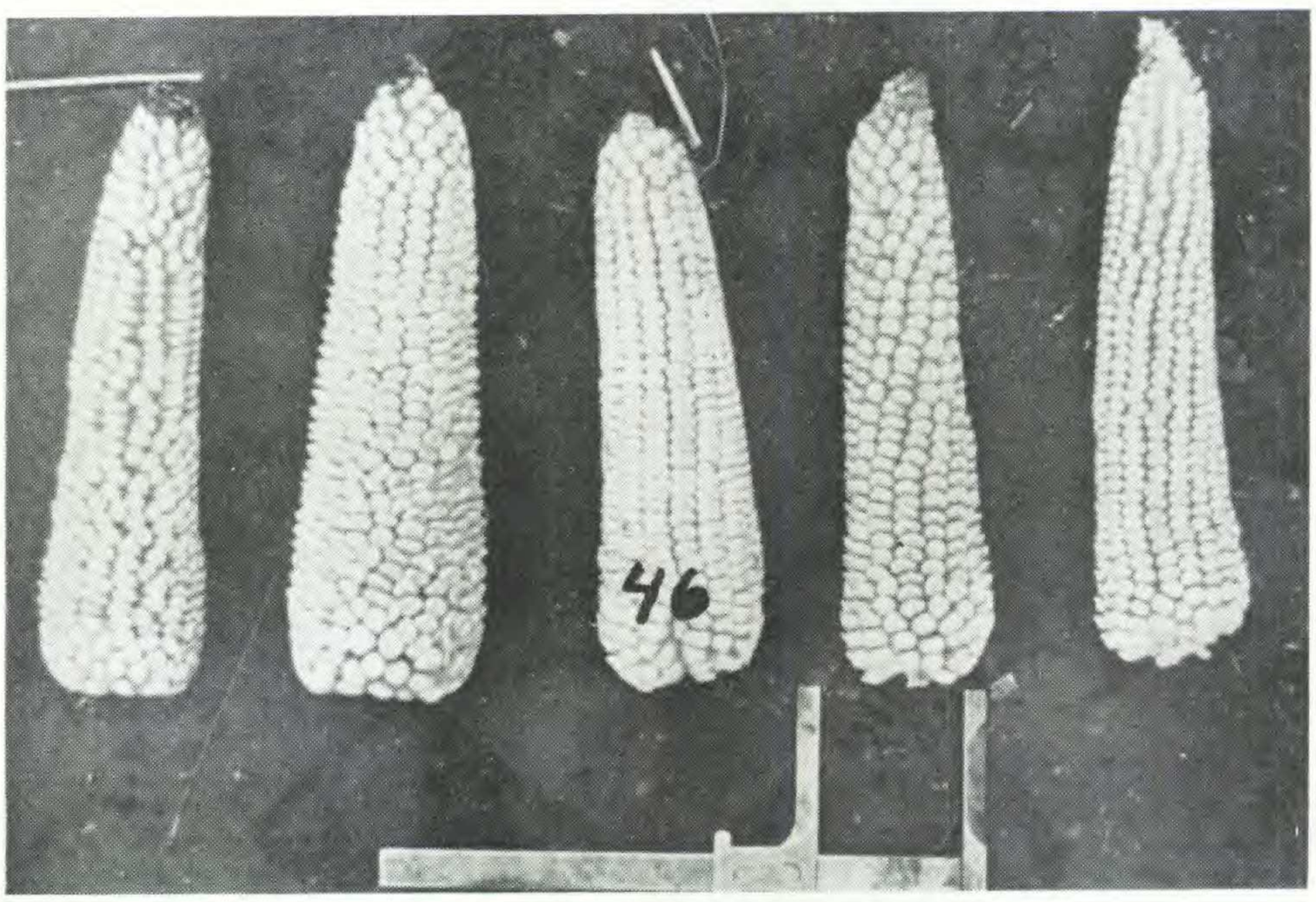
This is the black corn discussed in detail in the Appendix to Beal's report on Cherán. Prevailingly dark aleurone *(Pr)*, many with light to dark red purple in the pericarp (alleles of *R*?).

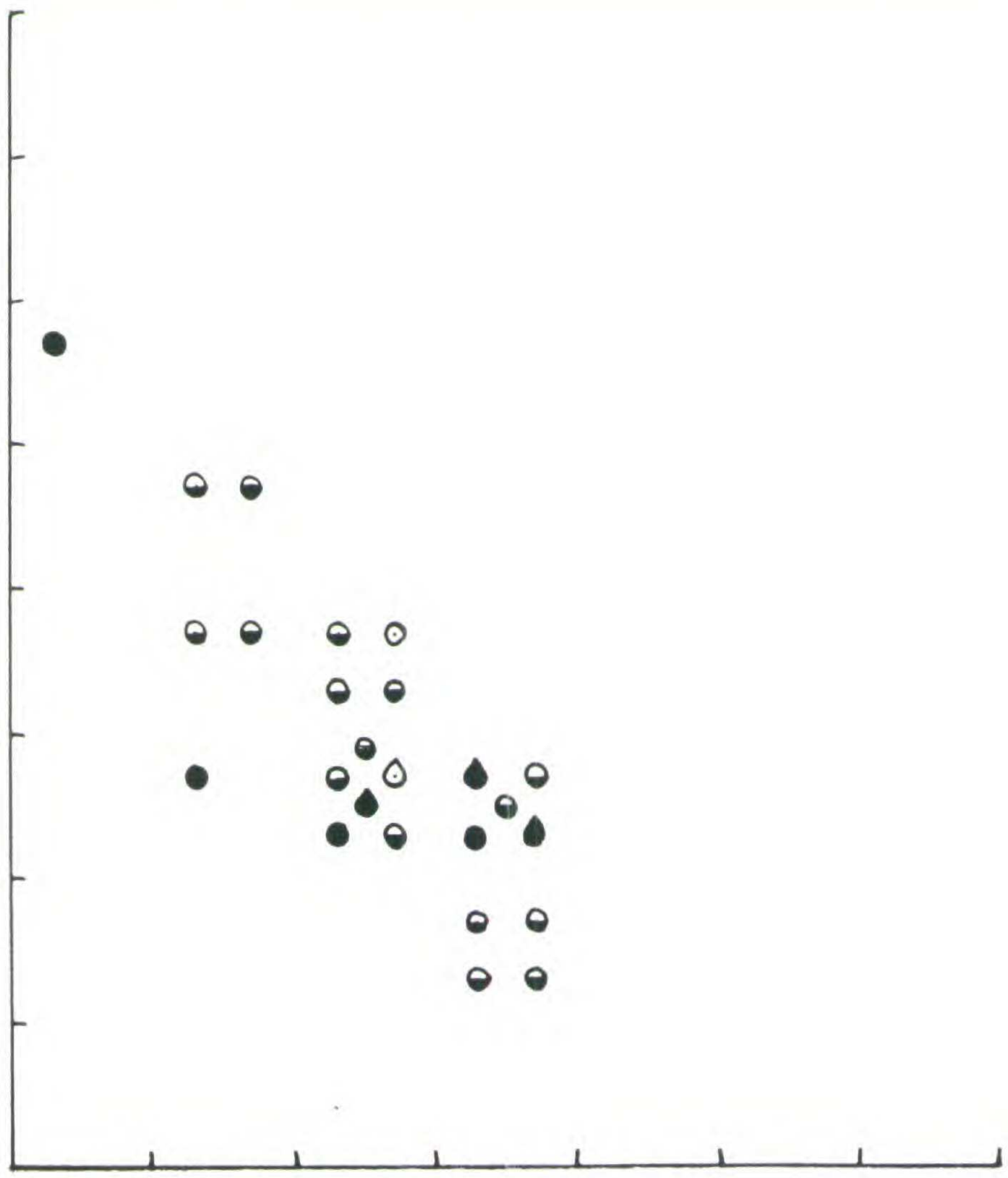




46. Cherán, Michoacán. *Maíz blanco del cerro*

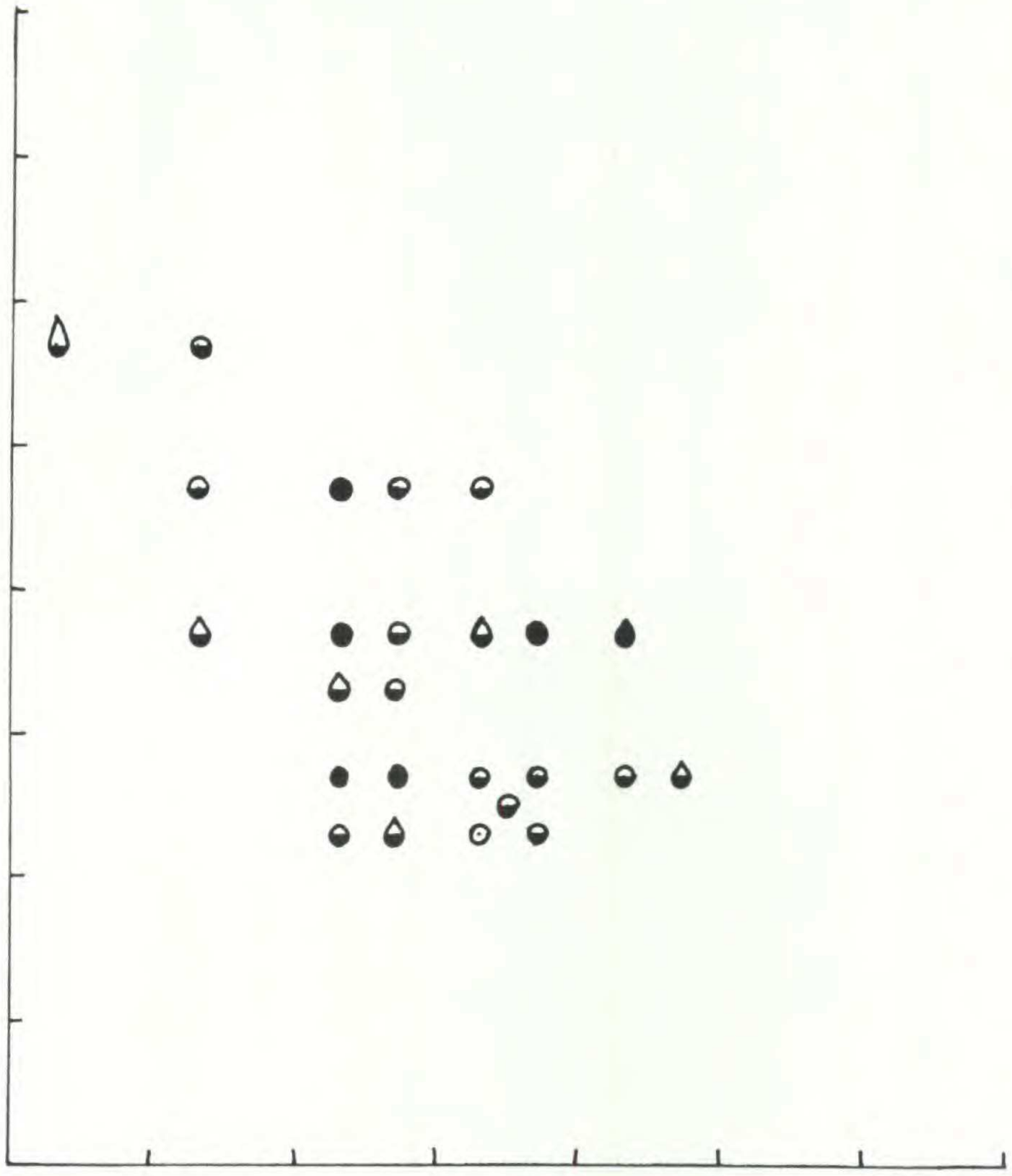
Prevailingly white with a few yellow kernels. Two ears had a few kernels with dark aleurone *(Pr)*. Two showed color in the pericarp.





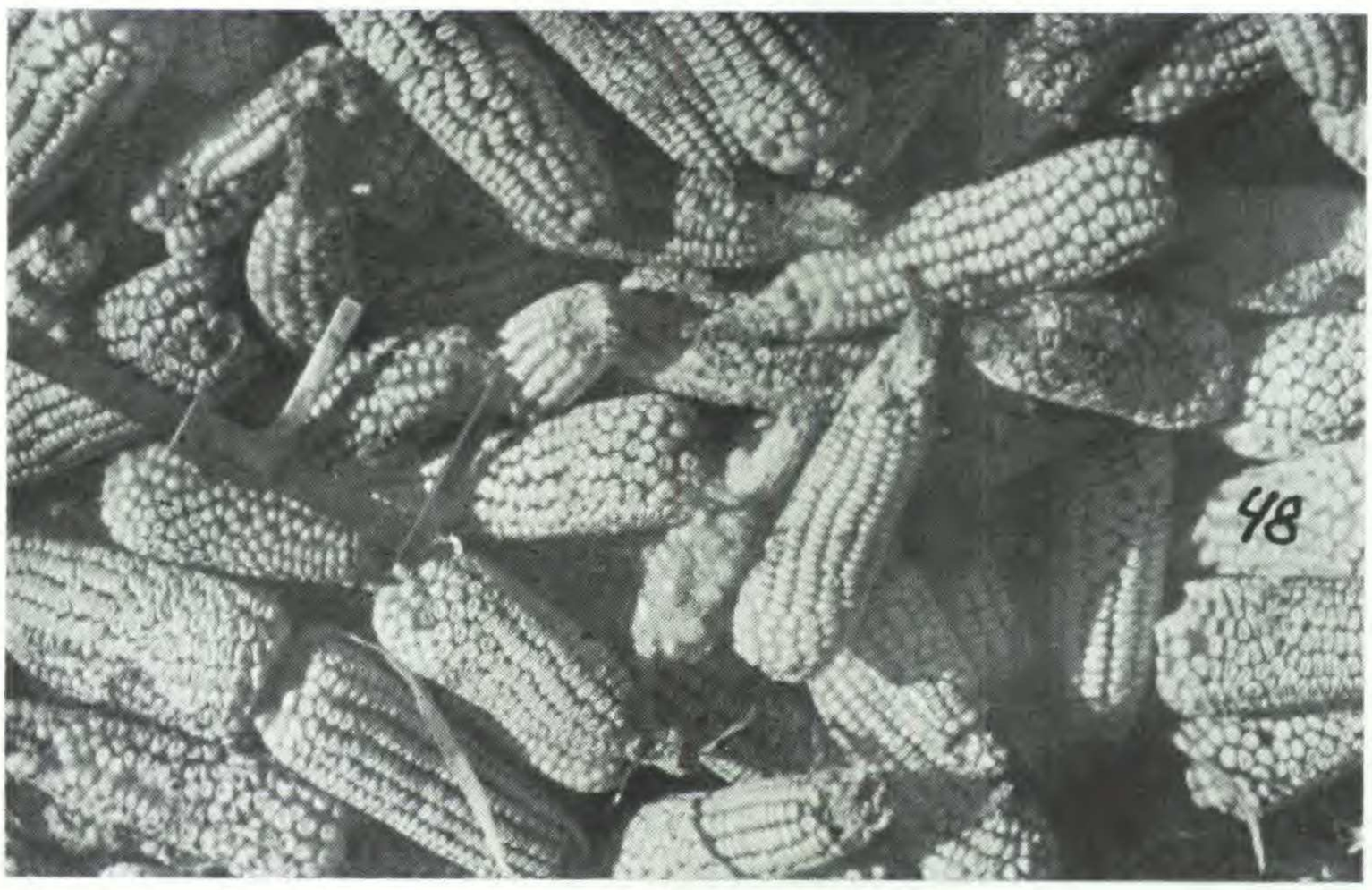
47. Pátzcuaro, Michoacán. *Maíz pinto*

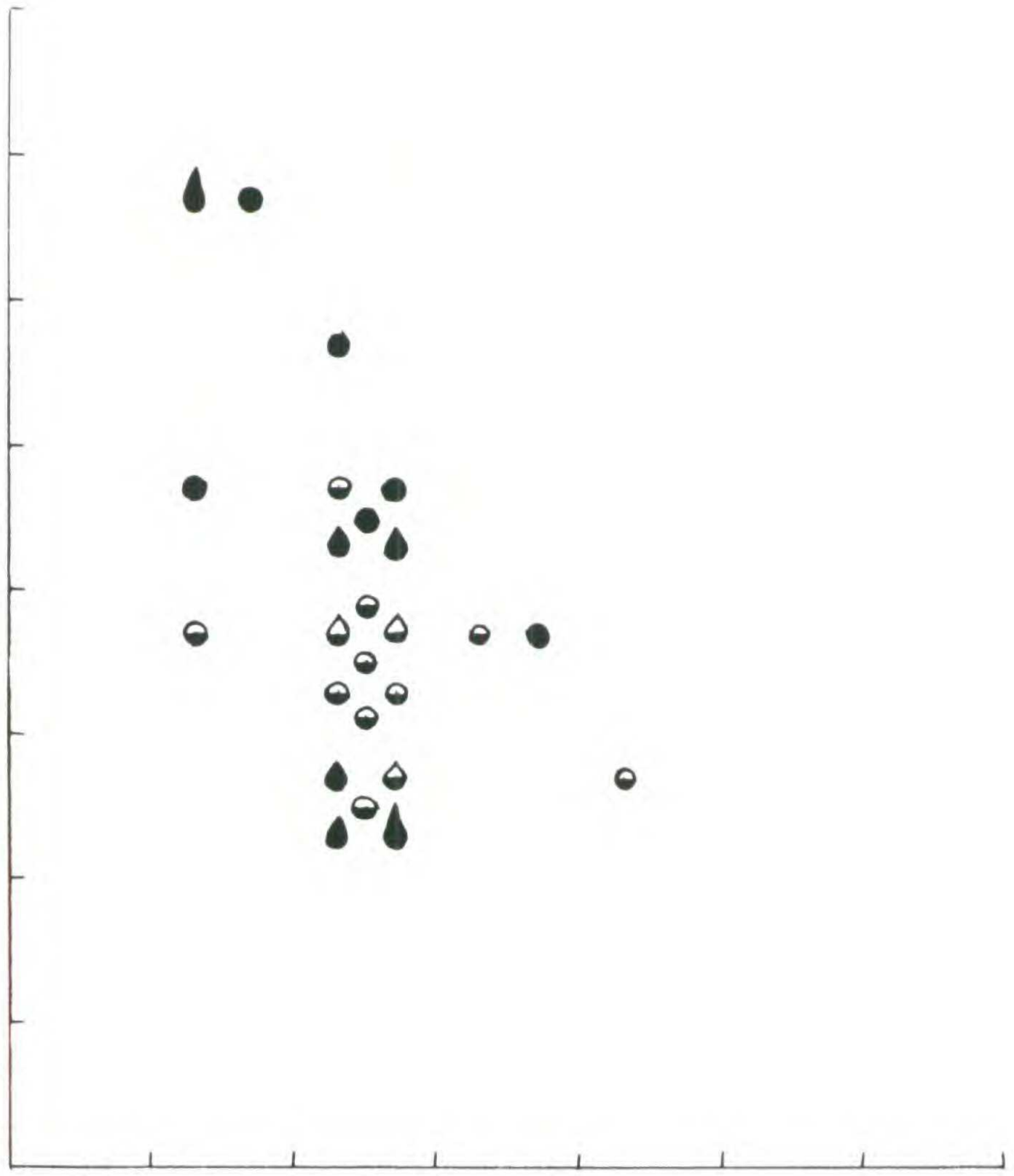
Grown on a small farm, "Las Paredis." Prevailingly white. Nearly all the ears with some kernels showing colored aleurone (usually *Pr*, sometimes *pr*).



48. Pátzcuaro, Michoacán. *Maíz blanco*

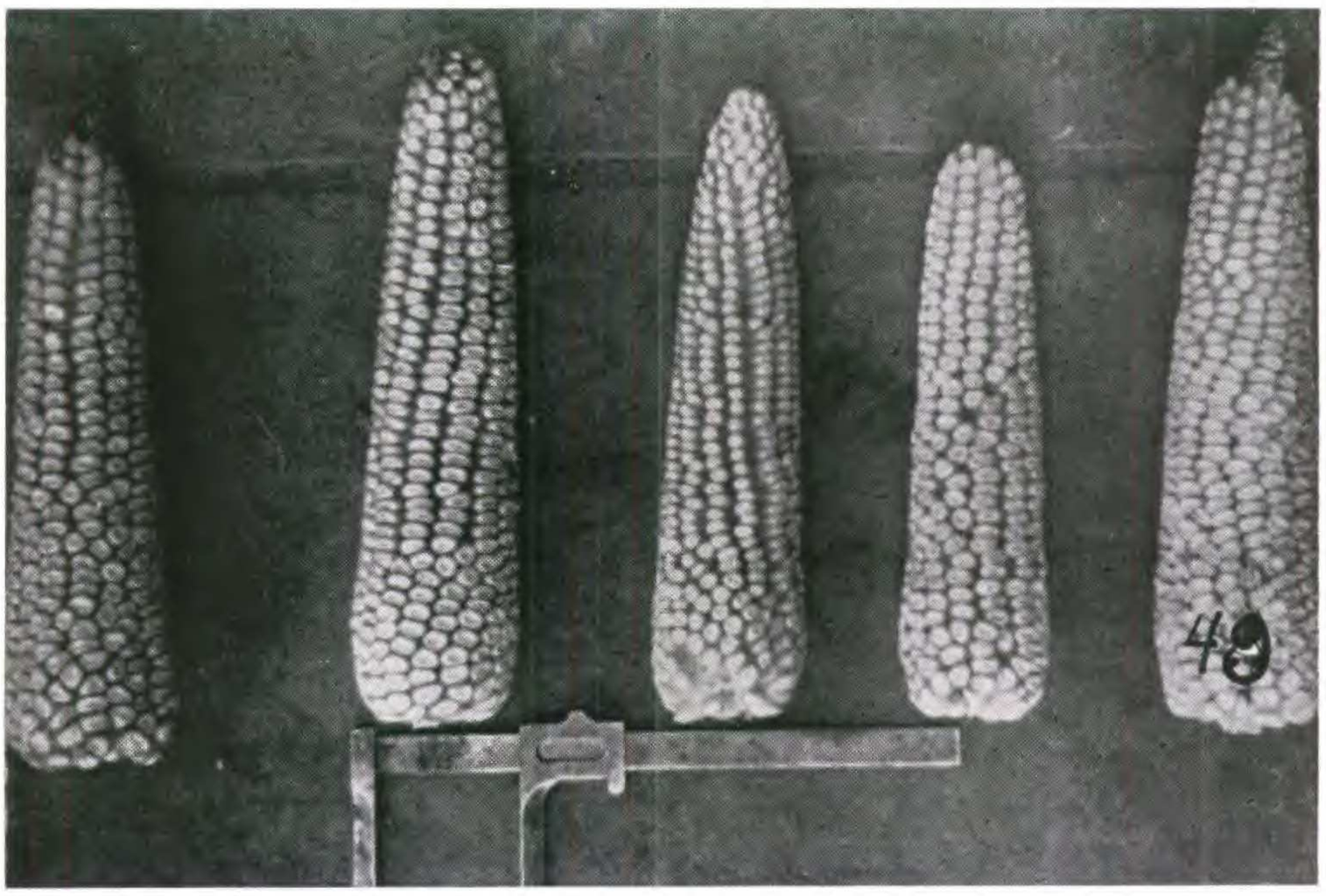
From a field one mile above the town. Prevailingly white and very pale yellow. Three ears with a few kernels with dark aleurone *(Pr)*; two ears with colored pericarp.

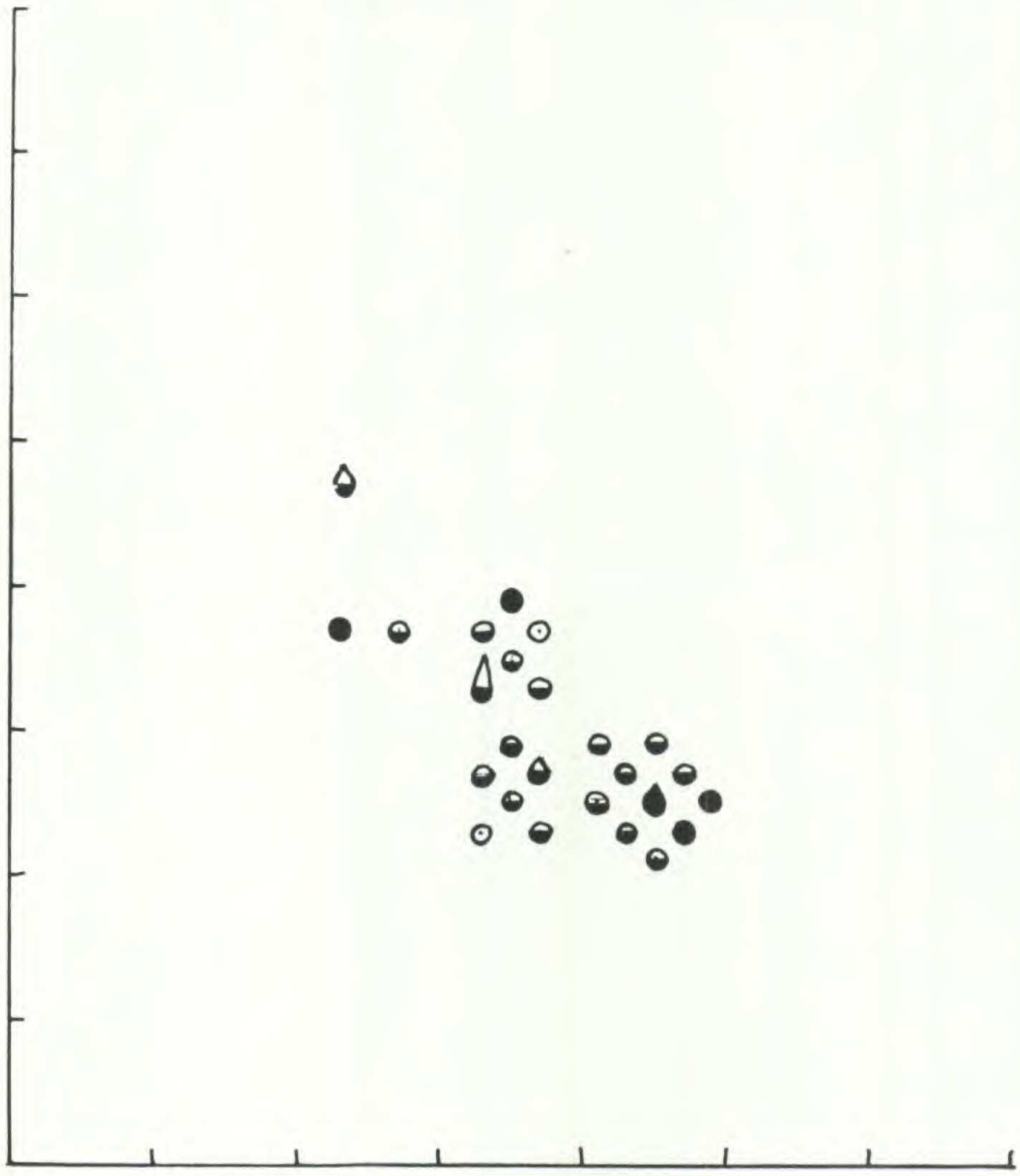




49. Lake Pátzcuaro, Michoacán. *Maíz blanco*

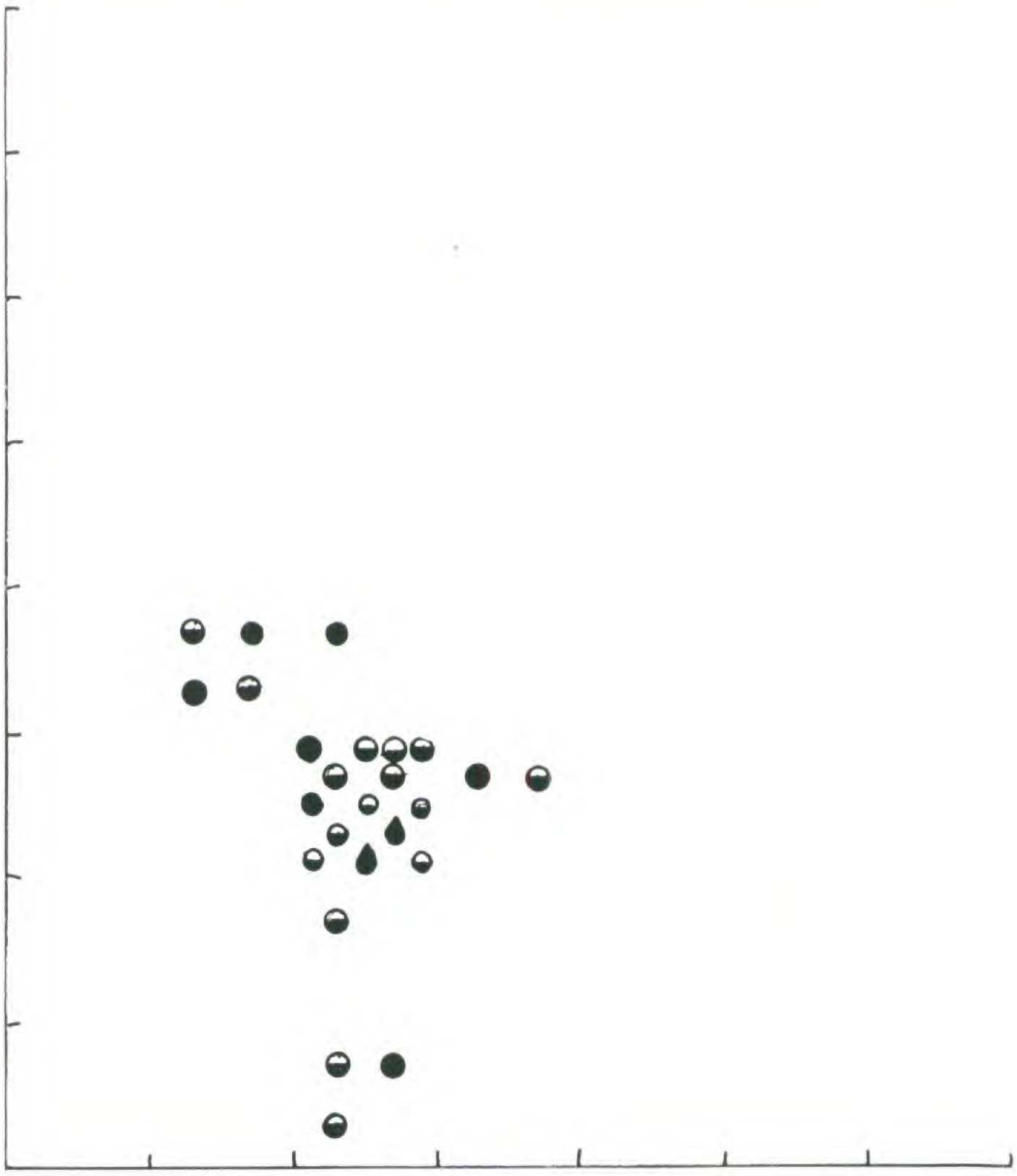
Prevailingly white. Most of the ears with some yellow kernels. Four ears with crowned pericarp *(P^{cr})*. Several ears with colored aleurone *(Pr* and *pr)*.





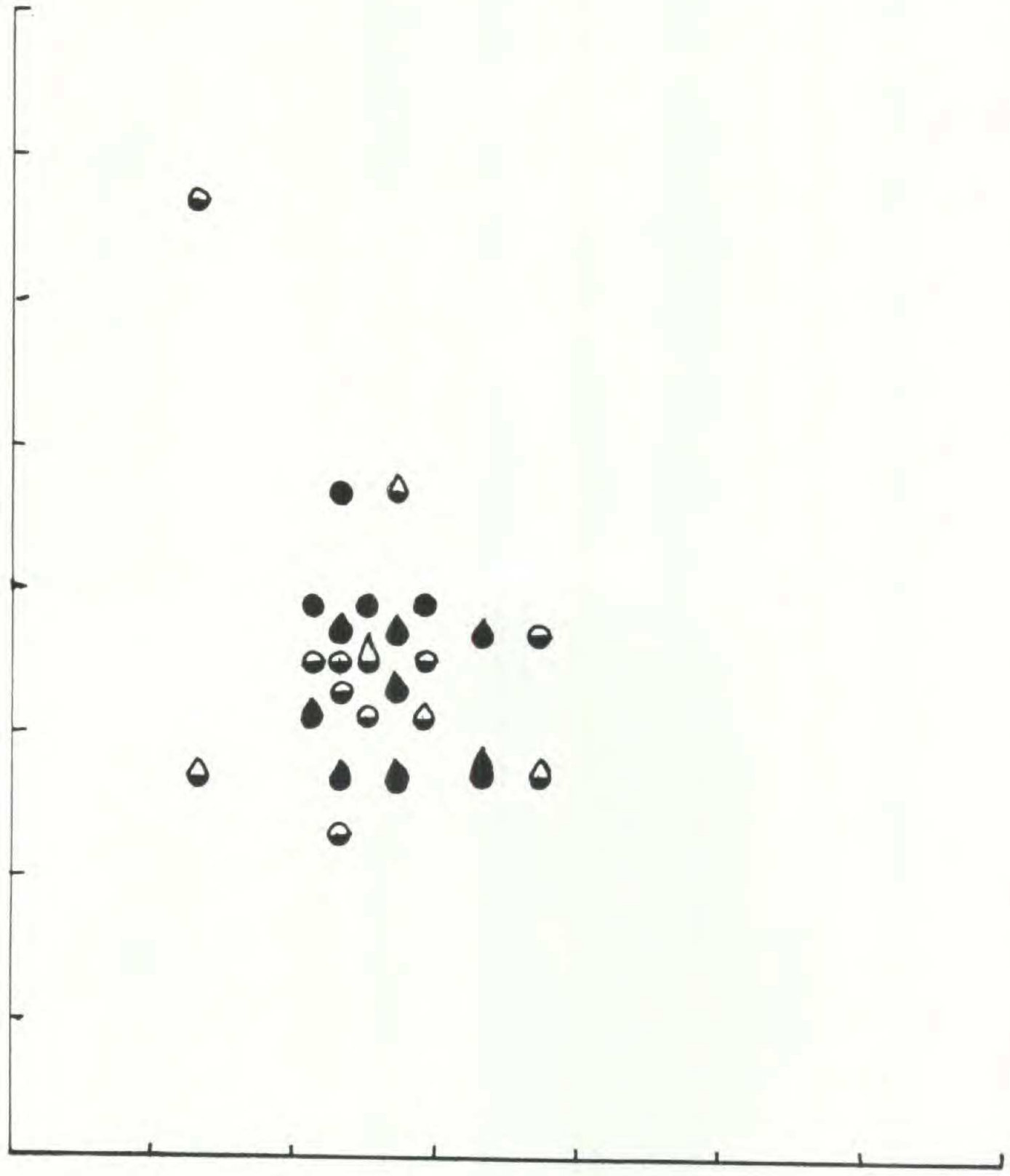
50. Lake Pátzcuaro, Michoacán. *Maíz colorado*

Prevailingly dark aleurone *(Pr)*, though many of the ears are segregating for reddish aleurone *(pr)* and a few are mainly *pr*. Over half the ears with a few to many white kernels, some of them due to pollination with dominant white (C^i); one ear, for example, had *Pr* and *pr* kernels and a single kernel of pure white with no trace of color.



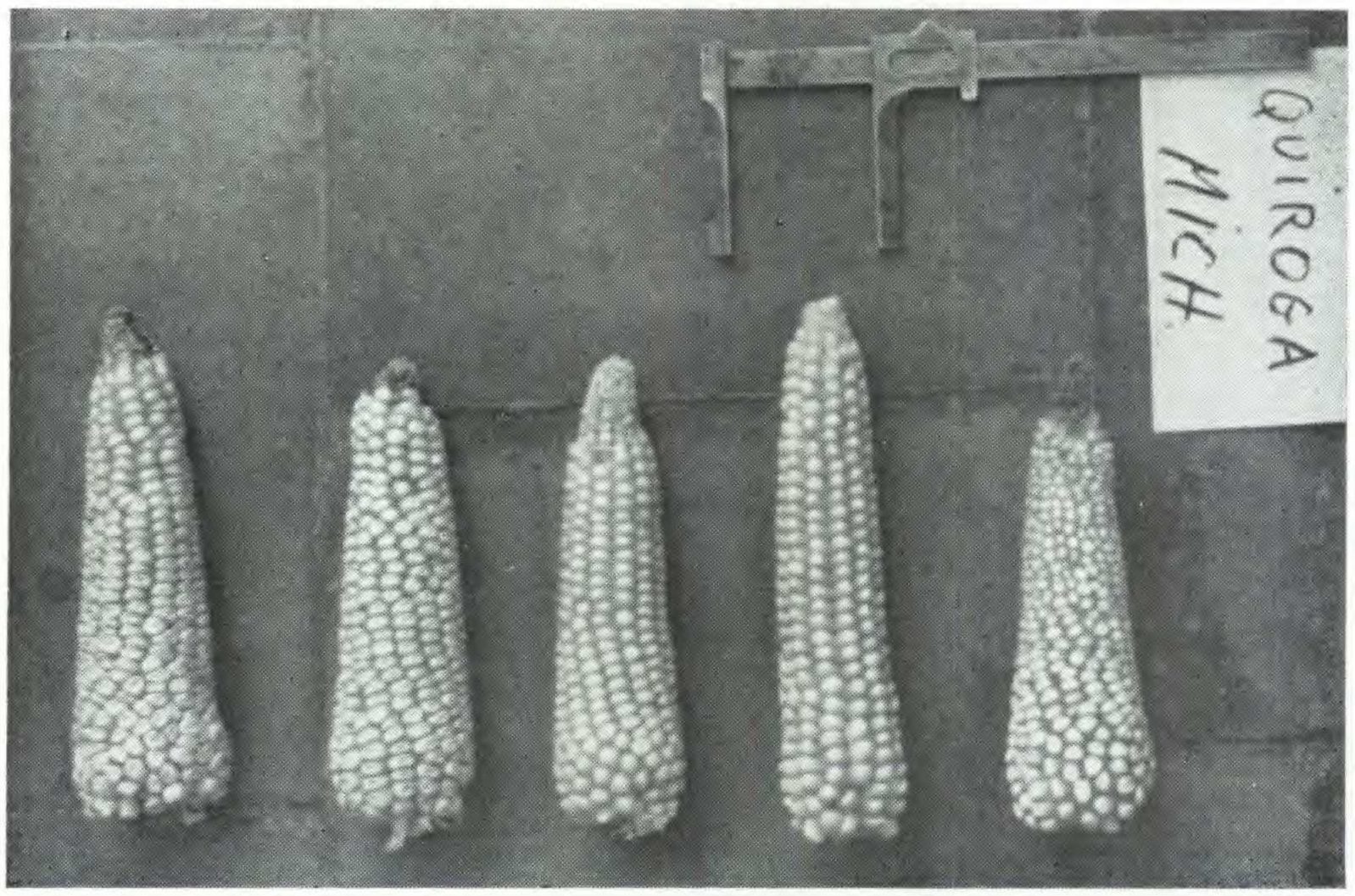
51. Zitácuaro, Michoacán

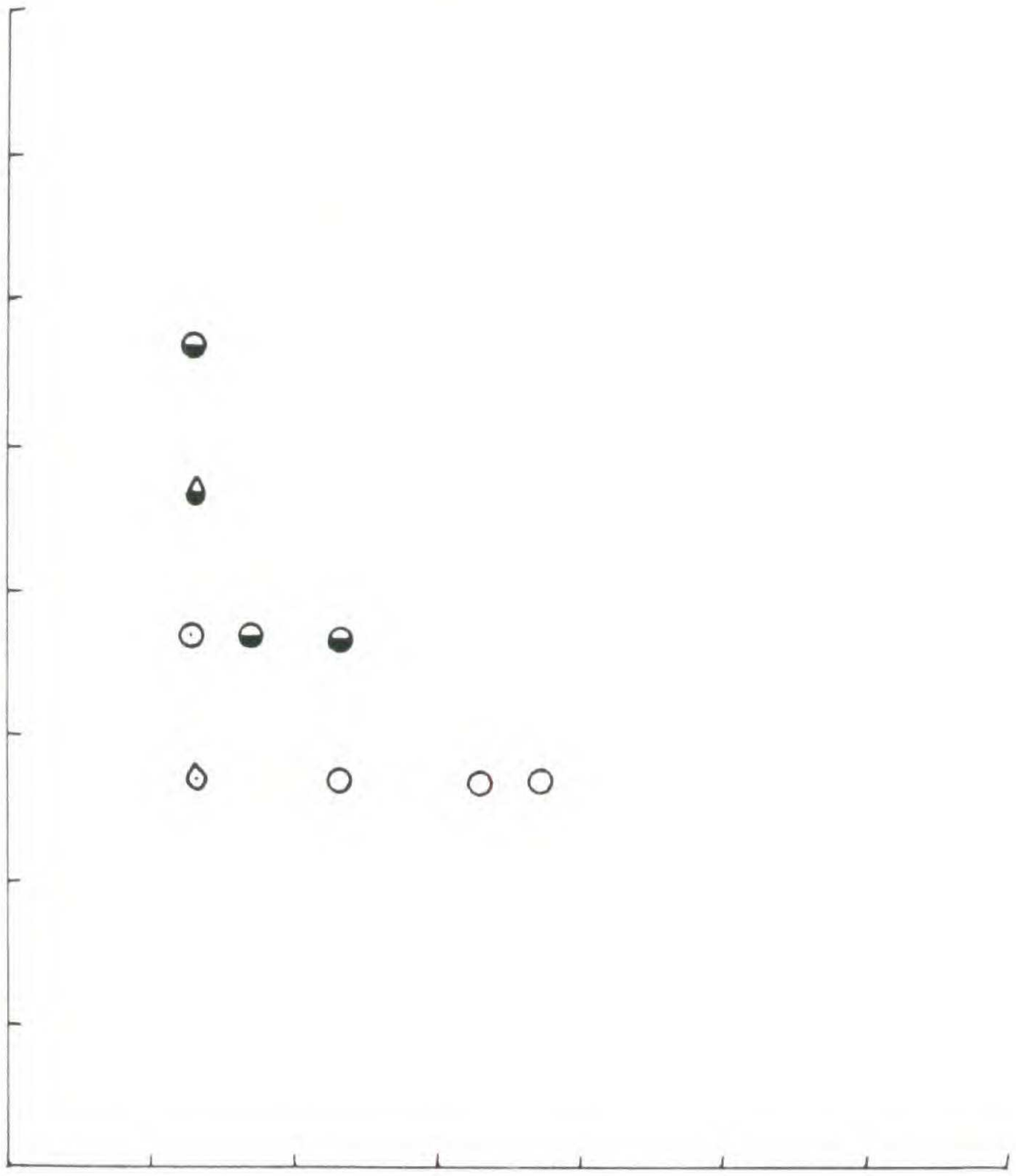
Collection by E. J. Wellhausen. Prevailingly white and pale yellow. Four of the ears had a faint reddish pericarp. Many of the ears were crooked in spite of being quite short. There is a slight error in this figure. Of the three ears indicated as having eight rows only the lower one was eight-rowed. The two others in the same square are really ten-rowed, and these two dots should have been slightly higher in the diagram.



52. Quiroga, Michoacán. *Maíz de tierra fria*

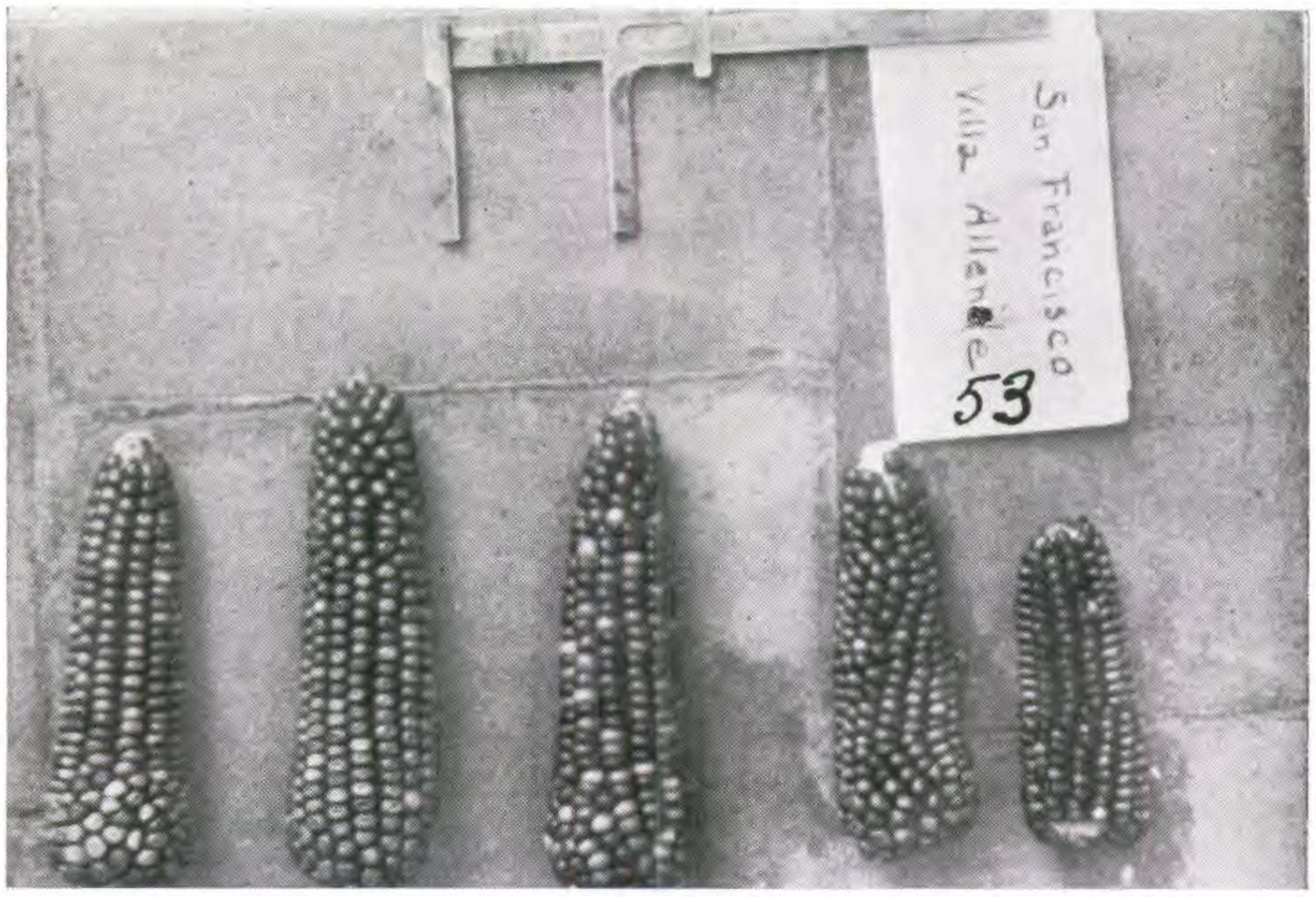
Collection by E. J. Wellhausen. Prevailingly white and pale yellow with a few ears with faint pink pericarp.

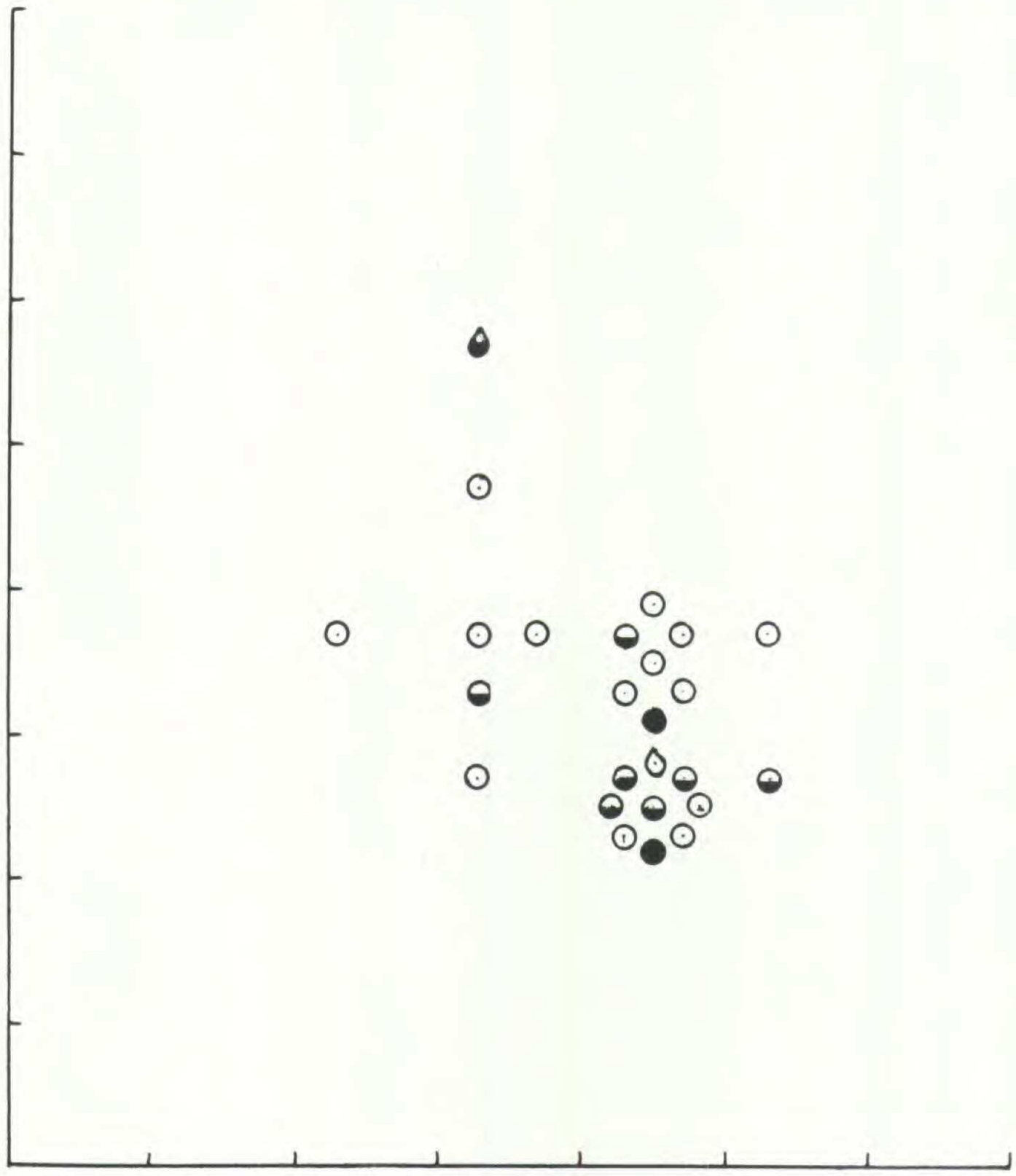




53. San Francisco, Villa Allende

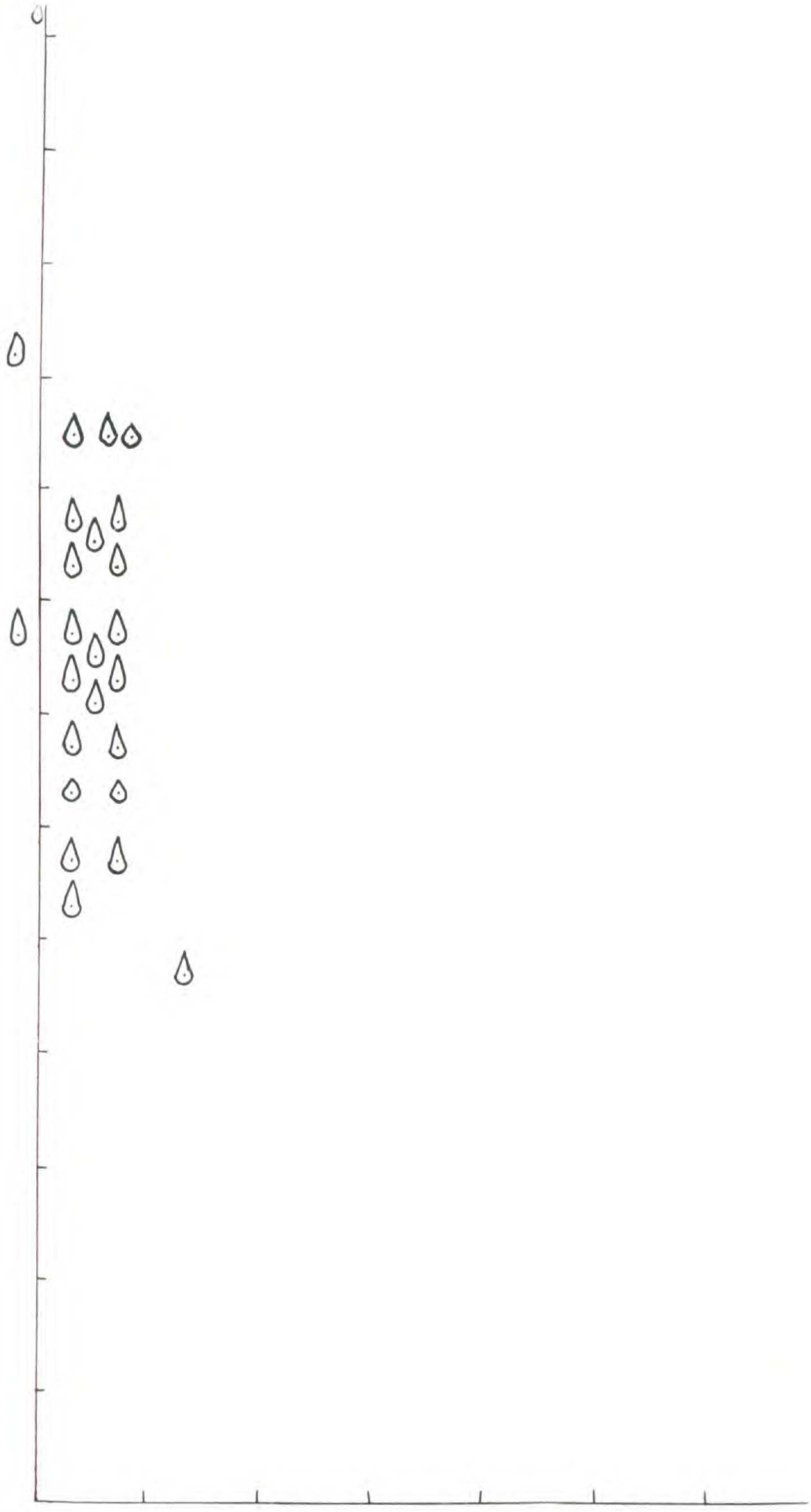
A small collection made by Dr. Wellhausen. All dark aleurone *(Pr)*. On half the ears the color is intensified by red pericarp *(P* and P^{cr}*)* which makes the dark blue into a shiny black.





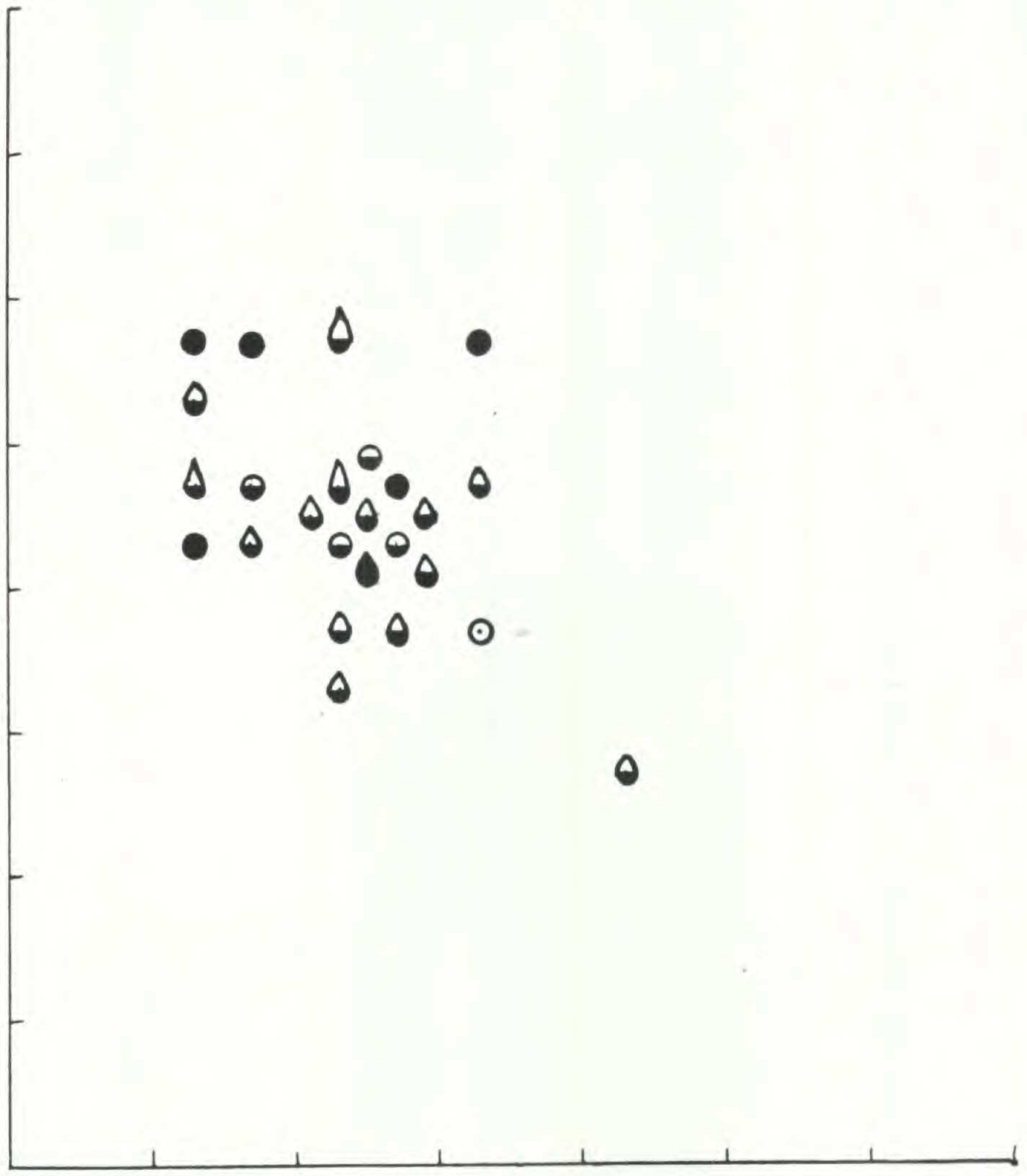
54. Mexico-Toluca Highway, Km. 60. *Cacahuazintle*

Nearly all pure white. One ear with five yellow kernels, all brilliant yellow and showing no capping of soft starch. Two ears with a few kernels of dark aleurone *(Pr)*; all of these very dark. Two ears shown in fig. 1, lower right. Two ears of this variety and from the same town are illustrated in fig. 1.



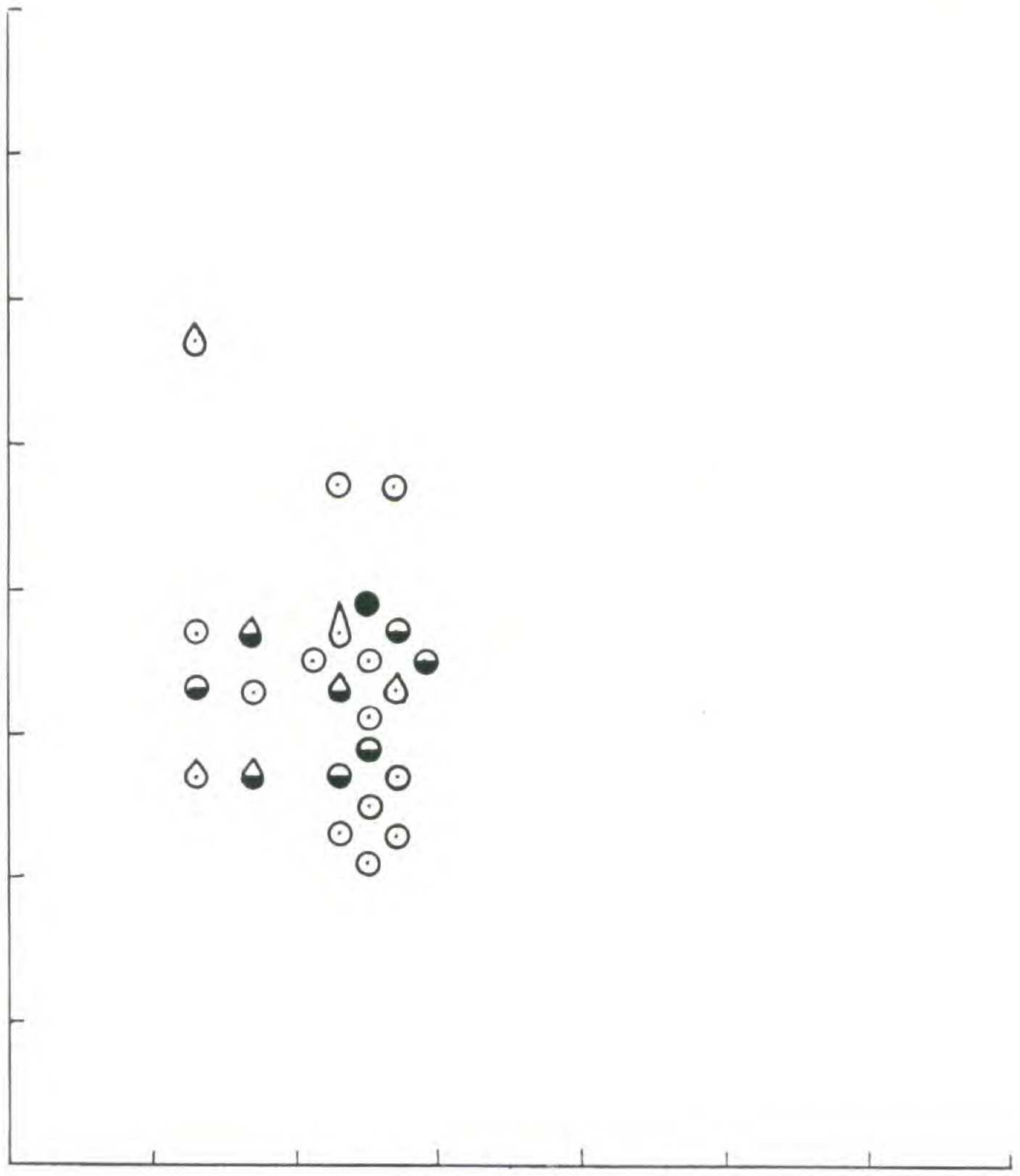
55. Mexico-Toluca, Km. 57

Prevailingly white endosperm, modified by the pinky tan and smoky colors of the pericarp. Three of the ears are strongly fasciated and look almost like "Japanese Hull-less" popcorn. One ear is illustrated in pl. 5, above. Note extension of vertical scale.



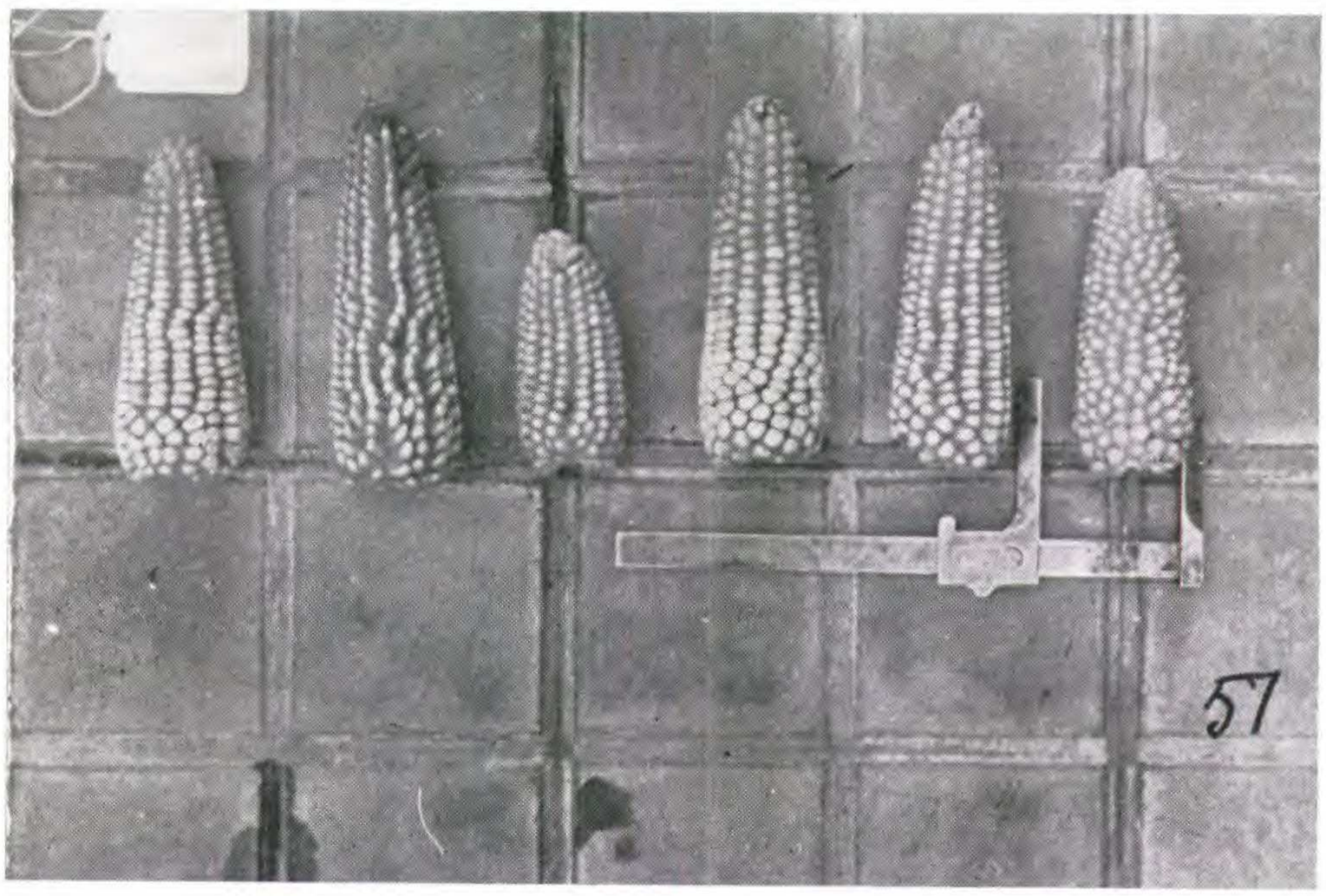
56. Mexico-Toluca, Km. 17

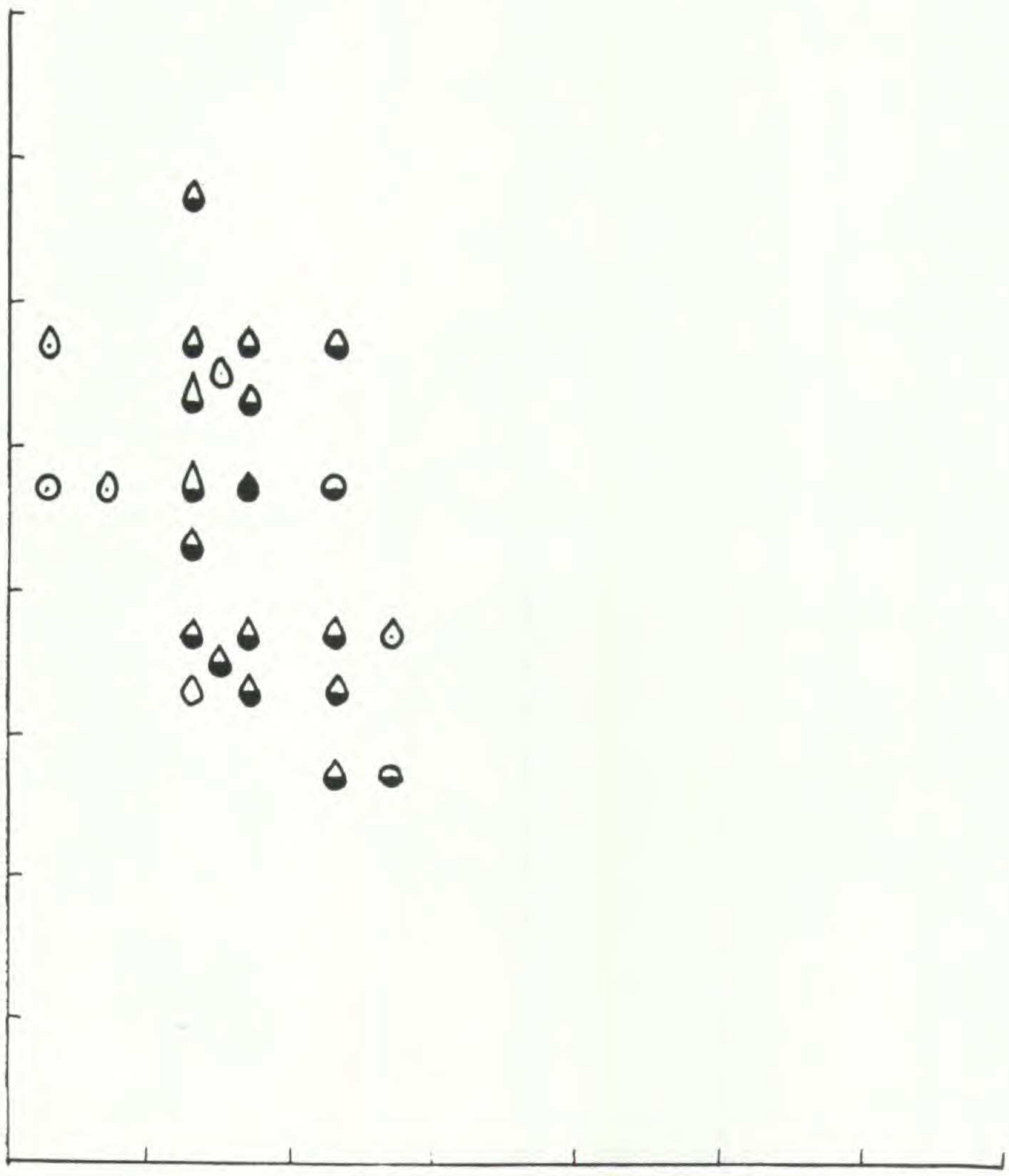
Collected by E. J. Wellhausen. Prevailingly white and light yellow. Four ears have a pinkish tan pericarp. One ear is strongly fasciated.



57. Mexico-Toluca, Km. 17

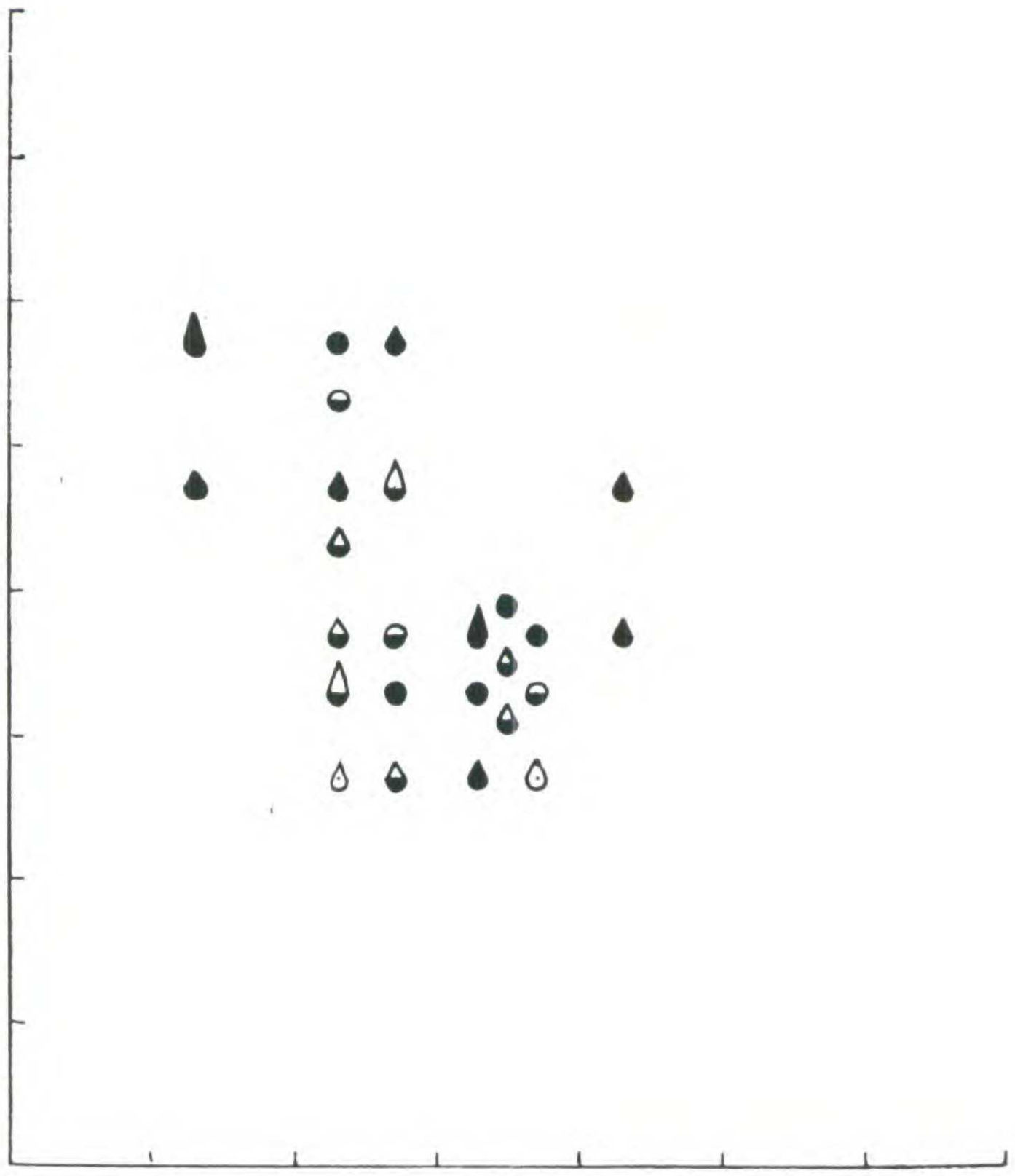
Collected by E. J. Wellhausen. Prevailingly bright yellow, with some light yellow and white. Two ears with a few kernels with dark aleurone *(Pr)*. Varying greatly from ear to ear in the amount of capping with soft starch.





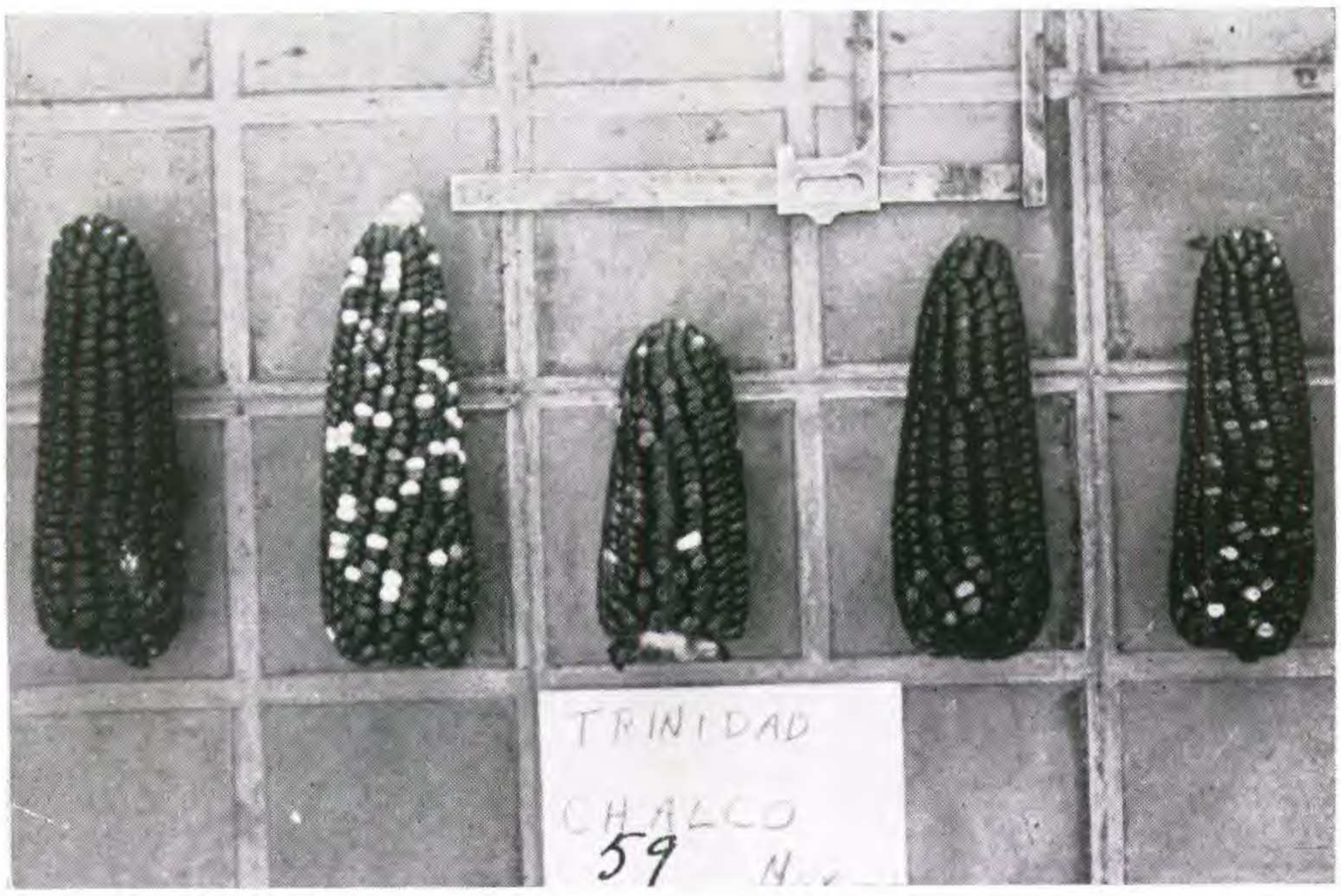
58. Mexico-Toluca, Km. 57 (Bag No. III)

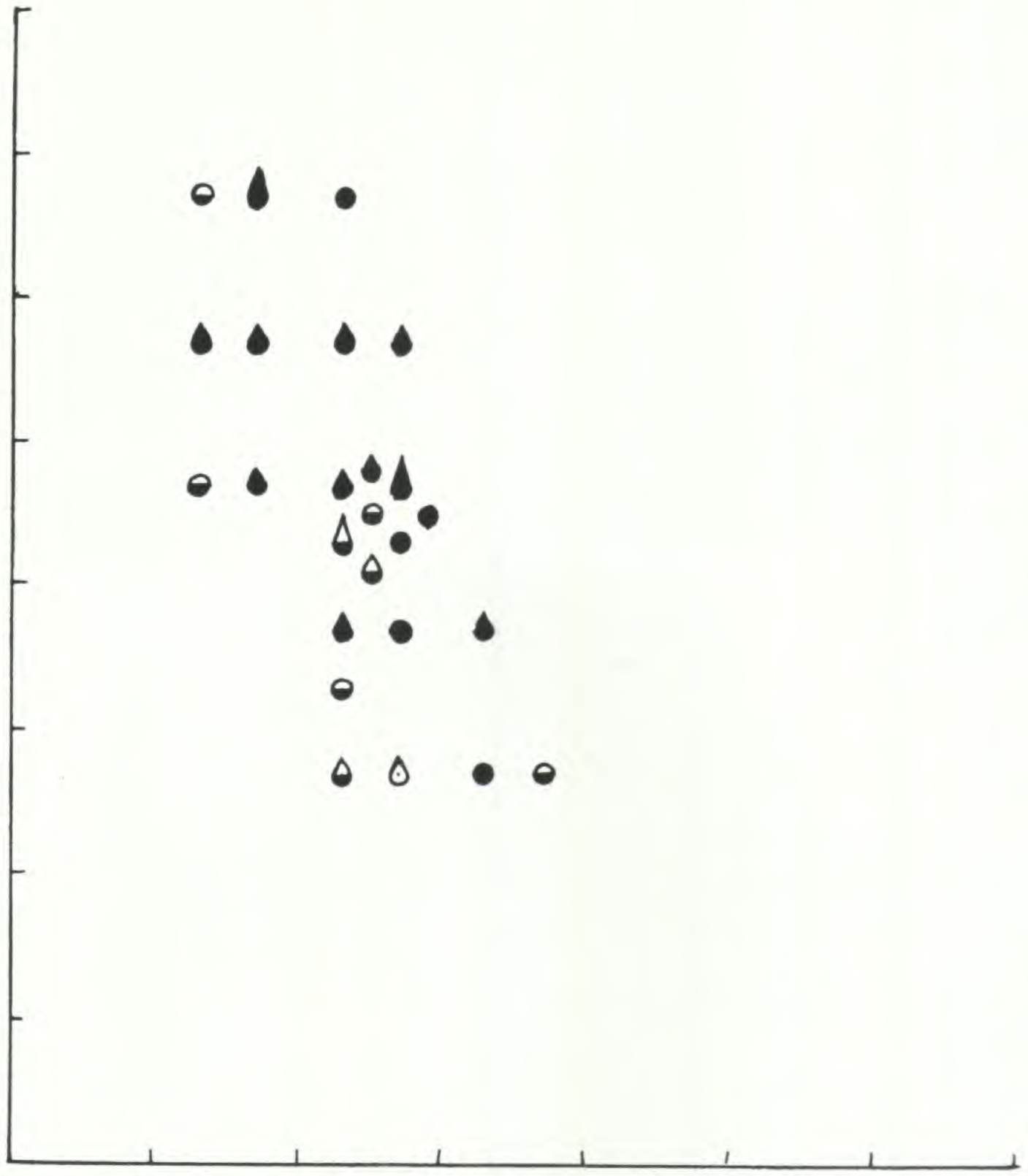
Collected by E. J. Wellhausen. Prevailingly white and yellow, the latter mostly very pale. Many kernels with faint dark aleurone (probably *Pr* and a semi-dominant white).



59. Chalco, Mexico

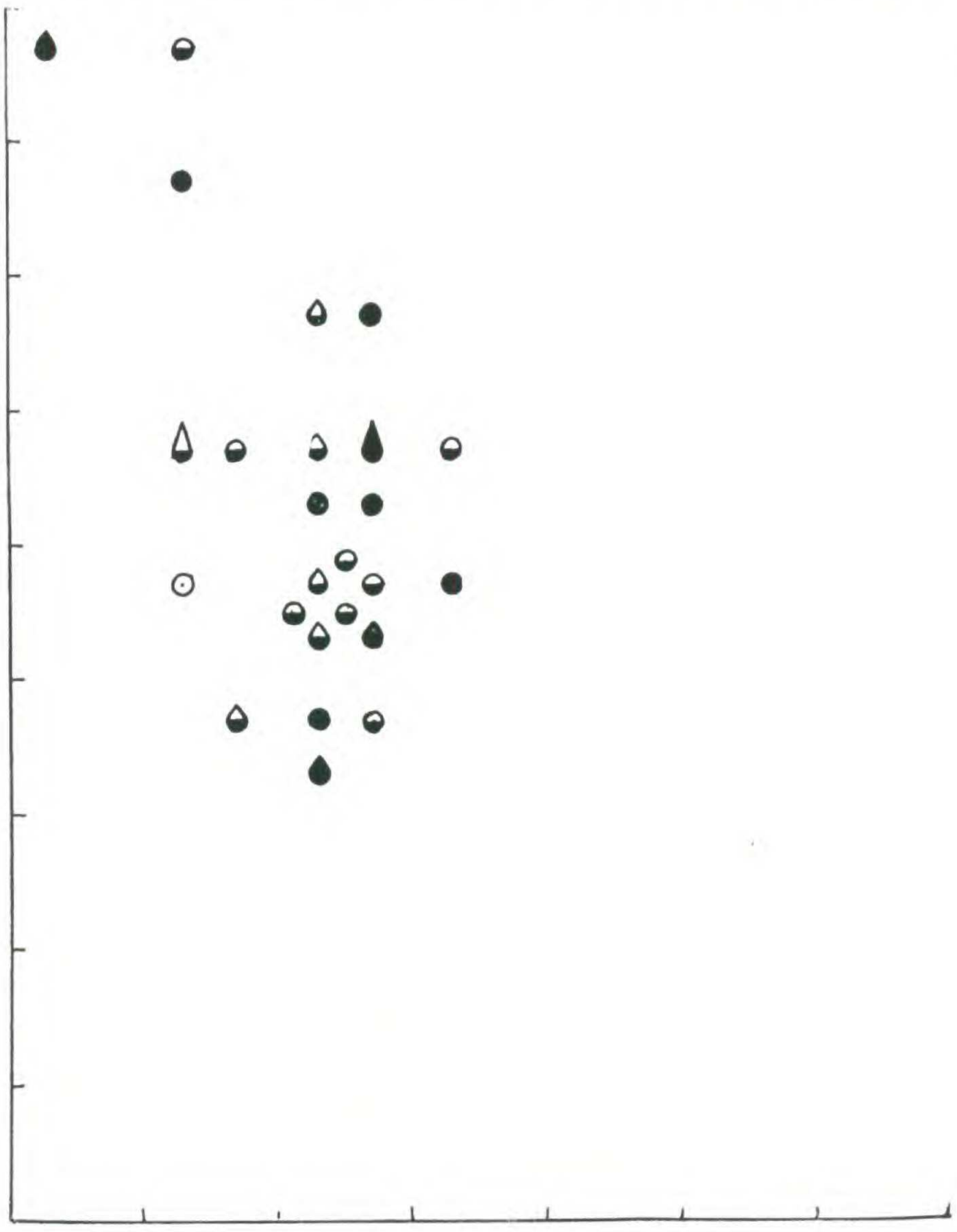
Collected by E. J. Wellhausen. All dark aleurone, one ear segregating for white. Most of the ears with occasional white or nearly white kernels. Six of the ears with red pericarp (*P* and P^{cr}).





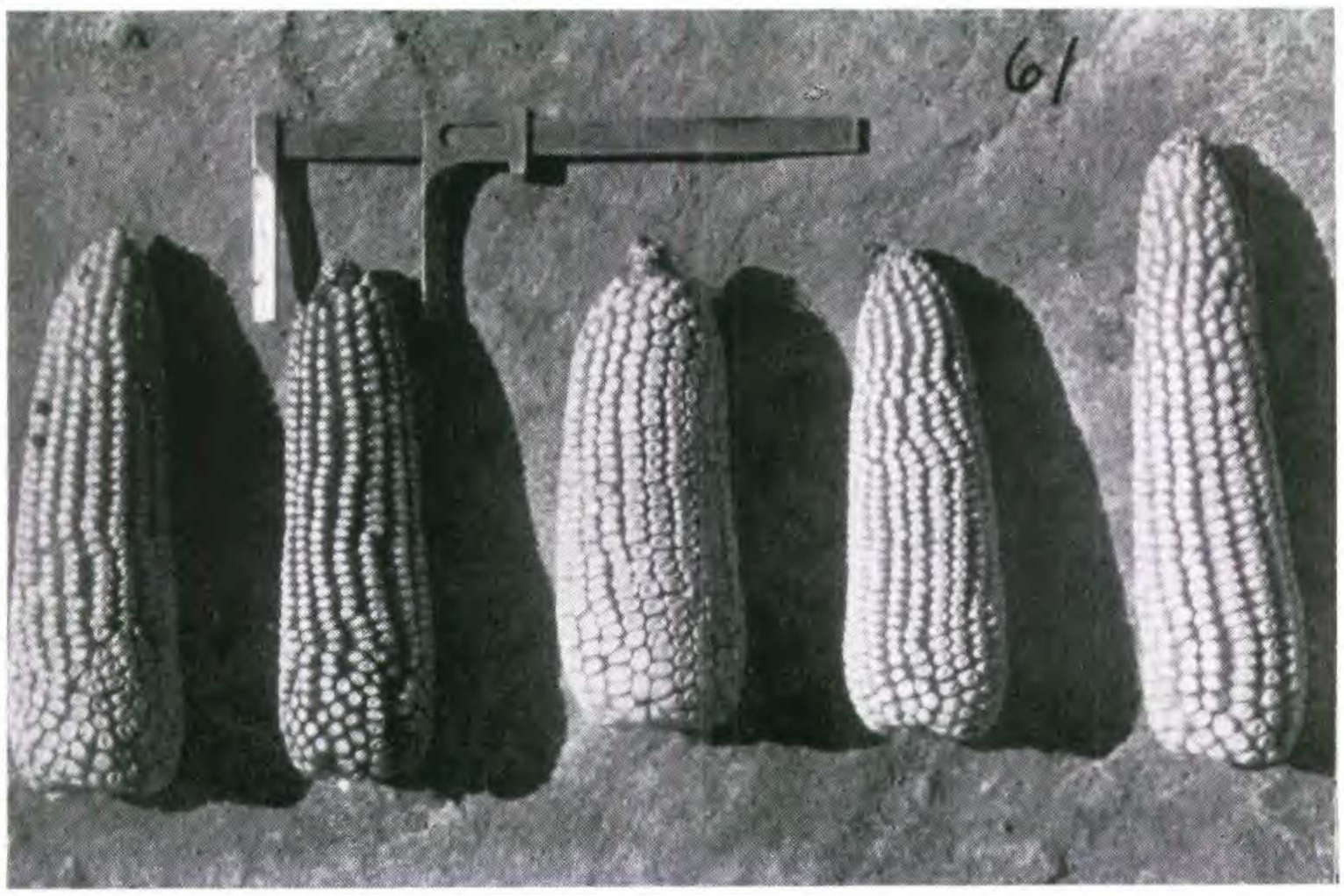
60. Metepec

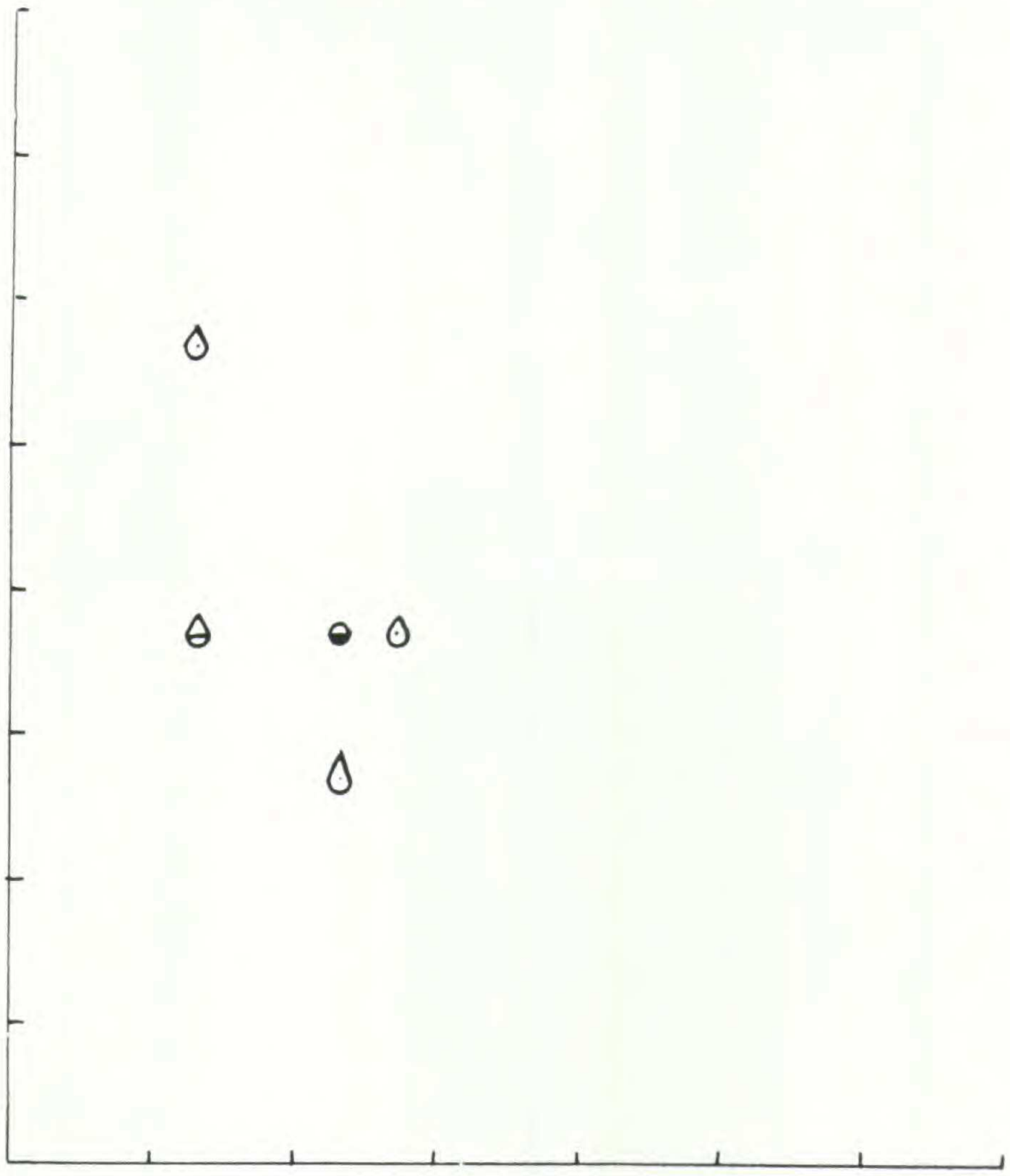
Collected by E. J. Wellhausen. All white and light ivory yellow.



61. Tepotzotlán, Mexico

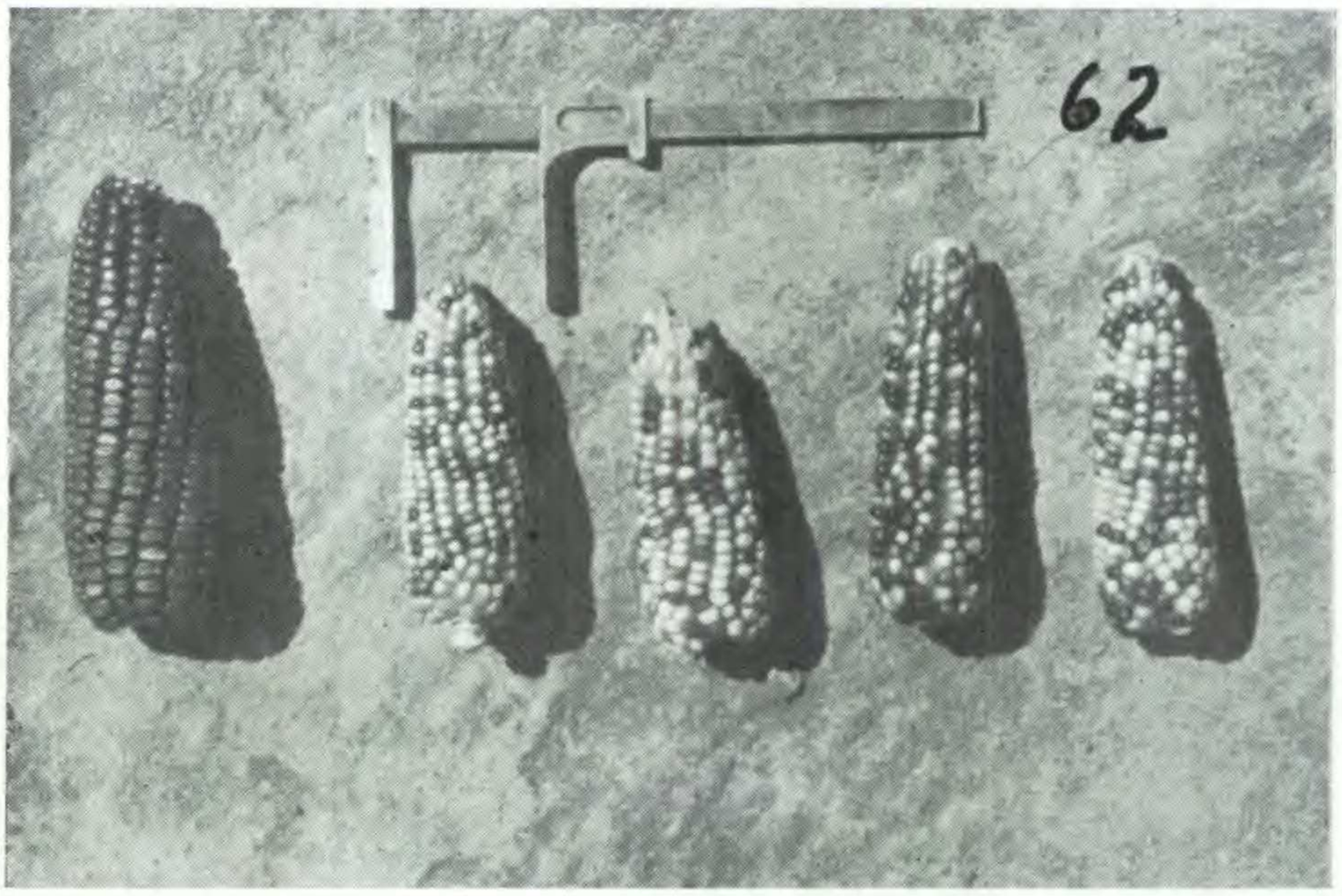
Prevailingly white and light ivory yellow. Two ears with pericarp color.

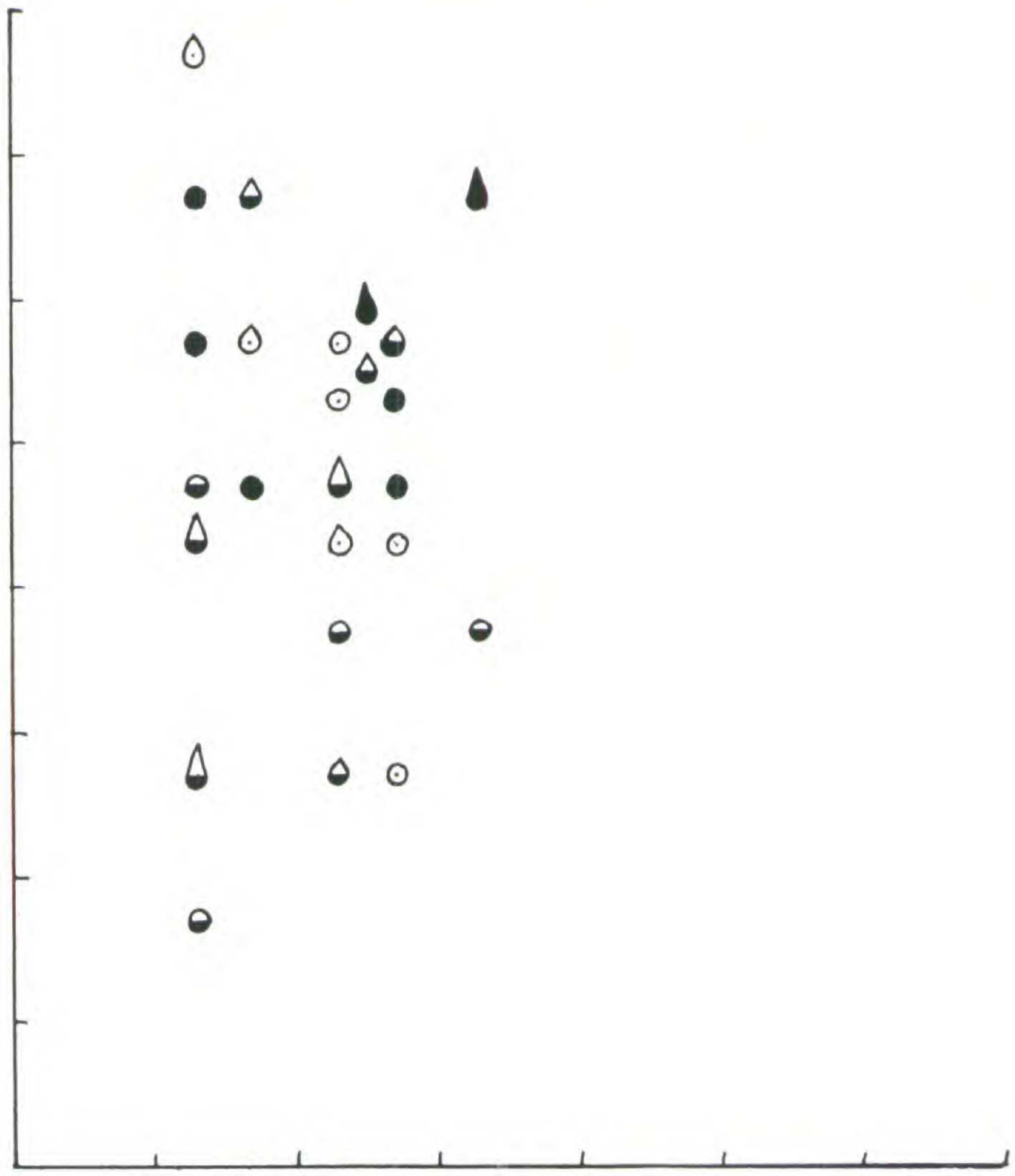




62. Tepotzotlán, Mexico

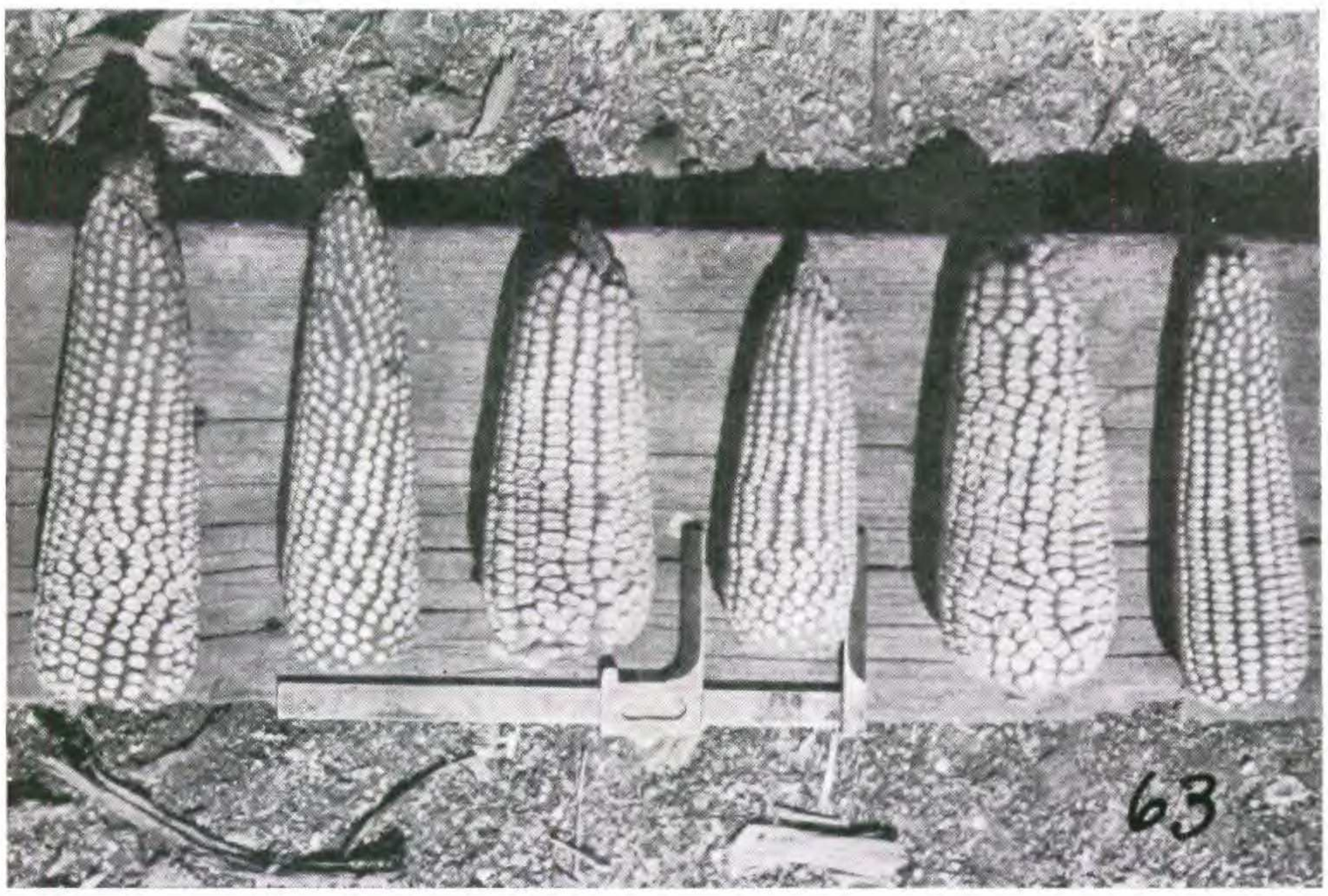
Small samples of two early varieties used for *pinole* and *elotes*.

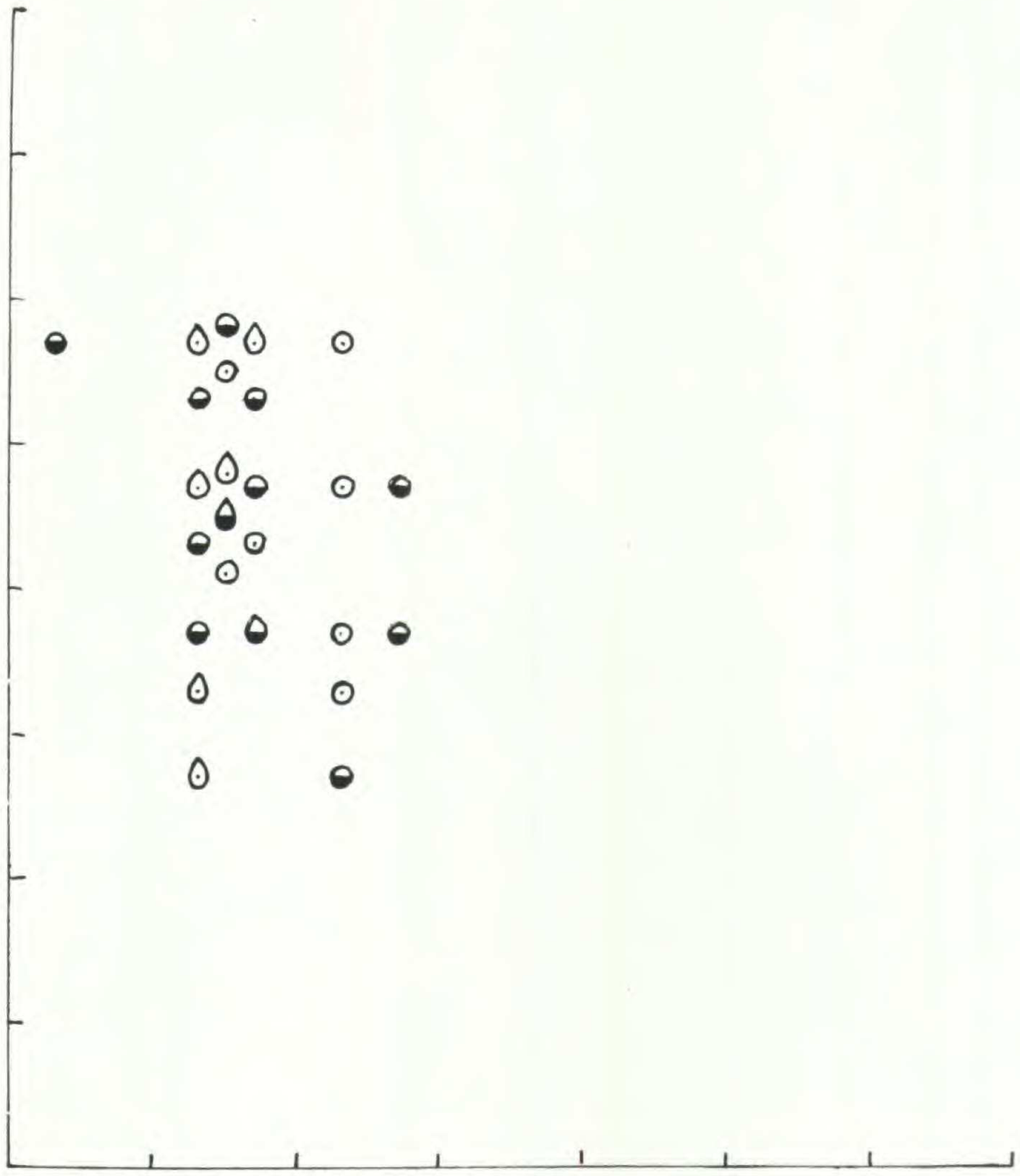




63. Huehuetoca, Mexico. *Maíz blanco*

Nearly all white. Four ears showed a few kernels with dark aleurone *(Pr)*. The ears photographed are the superior ones and not a random sample.





64. Acupula, Mexico. *Maíz morado apastillado*

Predominantly reddish aleurone *(pr)*, though every ear showed a few *Pr* and two ears were largely so. Most of the ears with a few white kernels *(C^i)*. Two ears with red pericarp. Said to be early seasoned. One ear illustrated in pl. 5, right below.